Appendix B
Aircraft Register Formats

DRAFT

Version 3.1

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B. Aircraft Register Formats

B.1 Introduction

The purpose of this Appendix is to specify technical provisions for the definition for data/message formats of aircraft registers which can be extracted using Ground Initiated Comm-B (GICB) protocols, as defined in Appendix C. In addition, this Appendix includes implementation guidelines for registers that are utilized in support of Elementary and Enhanced Surveillance.

Note: *Appendix B is arranged in the following manner:*

Section B.1 Introduction
Section B.2 Data Formats for Transponder Registers
Section B.3 BDS Registers Tables
Section B.4 Implementing Guidance

B.2 Data Formats for Transponder Registers

B.2.1 Register Allocation

Applications shall use the allocated Register numbers as shown in the Table B-2-1. The details of the data to be entered into the assigned Registers are defined in §B.3. Table B-2-1 specifies the minimum update rates at which the appropriate transponder Register(s) shall be reloaded with valid data. Any valid data shall be reloaded into the relevant Register field as soon as it becomes available at the Mode S Specific Services entity (SSE) interface, regardless of the update rate. If data is not available for a time no greater than twice the specified maximum update interval or 2 seconds (whichever is the greater), the status bit (if specified for that field) shall indicate that the data in that field is invalid and the field shall be ZEROed. The Register number shall be equivalent to the Comm-B data selector (BDS) value used to address that Register. The data link capability report (Register 10_{16}) shall be updated within one second of the data changing and at least every four (4) seconds thereafter.

Table B-2-1: GICB Register Number Assignments

Transponder Register No.	*Assignment*	*Maximum update interval (see Note 1)*
00_{16}	Not valid	N/A
01_{16}	Unassigned	N/A
02_{16}	Linked Comm-B, segment 2	N/A
03_{16}	Linked Comm-B, segment 3	N/A
04_{16}	Linked Comm-B, segment 4	N/A
05_{16}	Extended Squitter Airborne Position	0.2s
06_{16}	Extended Squitter Surface Position	0.2s
07_{16}	Extended Squitter Status	1.0s
08_{16}	Extended Squitter Identification and Category	15.0s
09_{16}	Extended Squitter Airborne Velocity	1.3s
$0A_{16}$	Extended Squitter Event-driven Information	Variable

Transponder Register No.	*Assignment*	*Maximum update interval (see Note 1)*
$0B_{16}$	Air/air information 1 (aircraft state)	1.3s
$0C_{16}$	Air/air information 2 (aircraft intent)	1.3s
$0D_{16}$-$0E_{16}$	Reserved for air/air state information	To be determined
$0F_{16}$	Reserved for TCAS/ACAS	To be determined
10_{16}	Data Link Capability Report	$\leq$4.0s
11_{16}-16_{16}	Reserved for extension to datalink capability reports	5.0s
17_{16}	Common usage GICB Capability Report	5.0s
18_{16} – $1C_{16}$	Mode S Specific Services Capability Reports	§2.2.24.3.5.3
$1D_{16}$-$1F_{16}$	Mode S Specific Services Capability Reports	5.0s
20_{16}	Aircraft Identification	5.0s
21_{16}	Aircraft and airline registration markings	15.0s
22_{16}	Antenna positions	15.0s
23_{16}	Reserved for antenna position	15.0s
24_{16}	Reserved for aircraft parameters	15.0s
25_{16}	Aircraft type	15.0s
26_{16}-$2F_{16}$	Unassigned	N/A
30_{16}	TCAS/ACAS Active Resolution Advisory	§2.2.22.1.2.1.3
31_{16}-$3F_{16}$	Unassigned	N/A
40_{16}	Selected vertical intention	1.0s
41_{16}	Next waypoint identifier	1.0s
42_{16}	Next waypoint position	1.0s
43_{16}	Next waypoint information	0.5s
44_{16}	Meteorological routine air report	1.0s
45_{16}	Meteorological hazard report	1.0s
46_{16}	Reserved for flight management system Mode 1	To be determined
47_{16}	Reserved for flight management system Mode 2	To be determined
48_{16}	VHF channel report	5.0s
49_{16}-$4F_{16}$	Unassigned	N/A
50_{16}	Track and turn report	1.3s
51_{16}	Position report coarse	1.3s
52_{16}	Position report fine	1.3s
53_{16}	Air-referenced state vector	1.3s
54_{16}	Waypoint 1	5.0s
55_{16}	Waypoint 2	5.0s
56_{16}	Waypoint 3	5.0s

Transponder Register No.	*Assignment*	*Maximum update interval (see Note 1)*
57_{16}-$5E_{16}$	Unassigned	N/A
$5F_{16}$	Quasi-static parameter monitoring	0.5s
60_{16}	Heading and speed report	1.3s
61_{16}	Extended Squitter Emergency/Priority Status	1.0s
62_{16}	Reserved for Target State and Status Information	N/A
63_{16}	Reserved for Extended Squitter	N/A
64_{16}	Reserved for Extended Squitter	N/A
65_{16}	Extended Squitter Aircraft Operational Status	2.5 s
66_{16}-$6F_{16}$	Reserved for Extended Squitter	N/A
70_{16}-75_{16}	Reserved for future aircraft downlink parameters	N/A
76_{16}-$E0_{16}$	Unassigned	N/A
$E1_{16}$-$E2_{16}$	Reserved for Mode S BITE	N/A
$E3_{16}$	Transponder type/part number	15 s
$E4_{16}$	Transponder software revision number	15 s
$E5_{16}$	TCAS/ACAS unit part number	15 s
$E6_{16}$	TCAS/ACAS unit software revision number	15 s
$E7_{16}$-$F0_{16}$	Unassigned	N/A
$F1_{16}$	Military applications	15 s
$F2_{16}$	Military applications	15 s
$F3_{16}$-FF_{16}	Unassigned	N/A

Note: *The term "minimum update rate" is used in this document. The minimum update rate is obtained when data is loaded in one Register field once every maximum update interval.*

B.2.2 General Conventions on Data Formats

B.2.2.1 Validity of Data

The bit patterns contained in the 56-bit transponder Registers (other than Registers accessed by BDS Codes 0,2; 0,3; 0,4; 1,0; 1,7 to 1,C; 2,0 and 3,0) are considered as valid application data only if:

1) The Mode S Specific Services capability bit is set in Register 10_{16}. This is indicated by bit 25 being set to "ONE," and

2) The GICB service corresponding to the application is shown as "supported" by the corresponding bit in the GICB capability report Registers 17_{16} to $1C_{16}$ being set to "ONE," and

Notes:

1. The intent of the capability bits in Register 17_{16} is to indicate that useful data are contained in the corresponding transponder Register. For this reason, each bit for a Register is cleared if data becomes unavailable (see ICAO Doc 9871, §A.2.5.4.1) and set again when data insertion into the Register resumes.

2. *A bit set in Registers 18_{16} to $1C_{16}$ indicates that the application using this Register has been installed on the aircraft. These bits are not cleared to reflect the real-time loss of an application, as is done for Register 17_{16} (see ICAO Doc 9871, §A.2.5.4.2).*

3) The data value is valid at the time of extraction. This is indicated by a data field status bit (if specified for that field). When this status bit is set to "ONE" the data field(s) which follow, up to the next status bit, are valid. When this status bit is set to "ZERO", the data field(s) are invalid.

B.2.2.2 Representation of Numeric Data

Numerical data shall be represented as follows:

1) Numerical data are represented as binary numerals. When the value is signed, 2s complement representation shall be used, and the bit following the status bit are the sign bit.

2) Unless otherwise specified, whenever more bits of resolution are available from the data source than in the data field into which that data are to be loaded, the data are rounded to the nearest value that can be encoded in that data field.

Note: *Unless otherwise specified, it is accepted that the data source may have less bits of resolution than the data field.*

3) When the data source provides data with a higher or lower range than the data field, the data are truncated to the respective maximum or minimum value that can be encoded in the data field.

4) In all cases where a status bit is specified in the data field it shall be set to "ONE" to indicate VALID and to "ZERO" to indicate INVALID.

Notes:

1. *This facilitates partial loading of the registers.*
2. *VALID indicates that the data contained in the field, represents real operational information which can be used by the application. This facilitates partial loading of the registers.*
3. *As an example, where ARINC 429 data are used, the single status bit specified in the field is derived from ARINC 429 status bits 30 and 31 bits as follows:*
   a) *If bits 30 and 31 represent "Failure Warning, No Computed Data" then the status bit shall be set to "INVALID".*
   b) *If bits 30 and 31 represent "Functional Test" then the status bit shall be set to "INVALID".*
   c) *If bits 30 and 31 represent "Normal Operation," "plus sign," or "minus sign," then the status bit shall be set to "VALID" provided that the data are being updated at the required rate (§B.2.1).*

d) If the data are not being updated at the required rate (§B.2.1), then the status bit shall be set to "INVALID".

5) When specified in the field, the switch bit indicates which of two alternative data types is being used to update the parameter in the transponder Register.

6) The bits in the MB field are numbered in the order of their transmission, beginning with bit 1. Unless otherwise stated, numerical values encoded by groups (fields) of bits are encoded using positive binary notation and the first bit transmitted is the most significant bit (MSB). Information will be coded in fields which consist of at least one bit.

7) Registers containing data intended for broadcast Comm-B have the broadcast identifier located in the eight most significant bits of the MB field.

Notes:

1. When multiple data sources are available, the one with the highest resolution should be selected.

2. By default, values indicated in the range of the different fields of registers have been rounded to the nearest integer value or represented as a fraction.

B.2.2.3 Representation of Alphanumeric Character Encoding

For Registers requiring alphanumeric character encoding, each character shall be coded as a 6-bit subset of the International Alphabet Number 5 (IA-5) as illustrated in Table B-2-2. The character code shall be transmitted with the high order unit (b6) first and the reported character string shall be transmitted with its left-most character first. Characters shall be coded consecutively without intervening SPACE code. Any unused character spaces at the end of the subfield shall contain a SPACE character code.

Table B-2-2: 6-Bit Subset of International Alphabet Number (IA-5) for Character Coding

				b6	0	0	1	1
				b5	0	1	0	1
b4	b3	b2	b1					
~~E~~0	0	0	0			P	SP	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K			
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			

SP – SPACE Code

B.3 BDS Register Formats

The definitions of the Registers herein are in conformance with ICAO Document 9871, 1st Edition. Tables are numbered B-3-X where "X" is the decimal equivalent of the BDS code Y,Z where Y is the BDS1 code and Z is the BDS2 code, used to access the data format for a particular Register. The following tables are not included in this section:

B-3-1
B-3-2 to B-3-4 (Used by the linked Comm-B protocol)
B-3-5 to B-3-6 (Reserved for extended squitter)
B-3-8 to B-3-12 (Reserved for extended squitter)
B-3-13 to B-3-14 (Reserved for air/air state information)
B-3-15 (Reserved for TCAS/ACAS)
B-3-17 to B-3-22
B-3-35 (Reserved for antenna position)
B-3-36 (Reserved for aircraft parameters)
B-3-38 to B-3-47
B-3-49 to B-3-63
B-3-68 to B-3-69 (Reserved for meteorological reports)
B-3-70 to B-3-71
B-3-73 to B-3-79
B-3-87 to B-3-94
B-3-99 to B-3-100 (Reserved for extended squitter)
B-3-102 to B-3-111 (Reserved for extended squitter)
B-3-112 to B-3-224
B-3-225 to B-3-226 (Reserved for Mode S BITE)
B-3-231 to B-3-240
B-3-243 to B-3-255

For additional information on the following ADS-B Registers, please reference RTCA/DO-260A:

Table B-3-5	BDS Code 0,5	Extended Squitter Airborne Position
Table B-3-6	BDS Code 0,6	Extended Squitter Surface Position
Table B-3-7	BDS Code 0,7	Extended Squitter Status [1]
Table B-3-8	BDS Code 0,8	Extended Squitter Aircraft Identification and Category
Table B-3-9a	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 1 and 2 – Velocity Over Ground)
Table B-3-9b	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 3 and 4 – Airspeed and Heading)
Table B-3-10	BDS Code 0,A	Extended Squitter Event-Driven Information
Table B-3-97	BDS Code 6,1	Extended Squitter Aircraft Status [1]
Table B-3-98	BDS Code 6,2	Target State and Status [1]
Table B-3-101	BDS Code 6,5	Extended Squitter Aircraft Operational Status [1]

Note 1: *The 1090 Extended Squitter Status Registers are actually provided in this section since they are not squittered and intended to be accessed through GICB protocols.*

Table B-3-7: BDS Code 0,7 – Extended Squitter Status

MB FIELD

1	MSB	TRANSMISSION RATE
2	LSB	SUBFIELD (TRS)
3		ALTITUDE TYPE SUBFIELD (ATS)
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		RESERVED
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To provide information on the capability and status of the extended squitter rate of the transponder.

Transmission rate subfield (TRS) shall be coded as follows:

0 = No capability to determine surface squitter rate
1 = High surface squitter rate selected
2 = Low surface squitter rate selected
3 = Reserved

Altitude type subfield (ATS) shall be coded as follows:

0 = Barometric altitude
1 = GNSS height (HAE)

Aircraft determination of surface squitter rate:

For aircraft that have the capability to automatically determine their surface squitter rate, the method used to switch between the high and low transmission rates shall be as follows:

a) Switching from high to low rate: Aircraft shall switch from high to low rate when the on-board navigation unit reports that the aircraft's position has not changed more than 10 meters in any 30 second interval. The algorithm used to control the squitter rate shall save the aircraft's position at the time that low rate is selected.

b) Switching from low to high rate: Aircraft shall switch from low to high rate as soon as the aircraft's position has changed by 10 meters or more since the low rate was selected.

For transponder-based implementations, the automatically selected transmission rate shall be subject to being overridden by commands received form the ground control.

Table B-3-11: BDS Code 0,B – Air-to-Air State Information 1 (Aircraft State)

MB FIELD

1	STATUS
2	MSB = 1024 knots
3	
4	
5	TRUE AIR SPEED
6	
7	
8	Range [0, 2047] knots
9	
10	
11	
12	LSB = 1.0 knot
13	SWITCH (0 = Magnetic heading 1 = True heading)
14	STATUS
15	SIGN
16	MSB = 90 degrees
17	
18	HEADING
19	
20	
21	Range [-180, +180] degrees
22	
23	
24	LSB = 360/1024 degrees
25	STATUS
26	SIGN
27	MSB = 90 degrees
28	
29	
30	
31	TRUE TRACK ANGLE
32	
33	
34	
35	
36	Range [-180, +180] degrees
37	
38	
39	
40	LSB = 360/32768 degrees
41	STATUS
42	MSB = 1024 knots
43	
44	
45	
46	GROUND SPEED
47	
48	
49	
50	
51	Range [0, 2048] knots
52	
53	
54	
55	LSB = 1/8 knot
56	RESERVED

PURPOSE: To report threat aircraft state information in order to improve the ability of TCAS/ACAS to evaluate the threat and select a resolution maneuver.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-12: BDS Code 0,C – Air-to-Air State Information 2 (Aircraft Intent)

MB FIELD

1	STATUS
2	MSB = 32768 feet
3	
4	
5	LEVEL OFF ALTITUDE
6	
7	
8	
9	Range [0, 65520] feet
10	
11	
12	
13	LSB = 16 feet
14	STATUS
15	SIGN
16	MSB = 90 degrees
17	
18	NEXT COURSE (TRUE GROUND TRACK)
19	
20	
21	Range [+180, -180] degrees
22	
23	
24	LSB = 360/1024 degrees
25	STATUS
26	MSB = 128 seconds
27	
28	TIME TO NEXT WAYPOINT
29	All ONEs = time exceeds 255 seconds
30	
31	
32	Range [0, 256] seconds
33	
34	LSB = 0.5 seconds
35	STATUS
36	SIGN
37	MSB = 8192 ft/min
38	
39	VERTICAL VELOCITY (UP IS POSITIVE)
40	
41	Range [-16384, +16320] ft/min
42	
43	
44	LSB = 64 ft/min
45	STATUS
46	SIGN
47	MSB = 45 degrees
48	
49	ROLL ANGLE
50	
51	Range [-90, 89] degrees
52	
53	LSB = 45/64 degrees
54	
55	RESERVED
56	

PURPOSE: To report threat aircraft state information in order to improve the ability of TCAS/ACAS to evaluate the threat and select a resolution maneuver.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-16: BDS Code 1,0 – Data Link Capability Report (§2.2.19.1.12.5)

MB FIELD

1	MSB
2	
3	
4	BDS Code 1,0
5	
6	
7	
8	LSB
9	Continuation flag (see 9)
10	
11	
12	RESERVED
13	
14	
15	
16	Reserved for TCAS/ACAS (see 15)
17	
18	
19	
20	Mode-S subnetwork version number (see 12)
21	
22	
23	
24	Transponder enhanced protocol indicator (see 4)
25	Mode-S specific services capability (see 2)
26	
27	Uplink ELM average throughput capability (see 13)
28	
29	Downlink ELM: throughput capability of downlink ELM
30	Containing the maximum number of ELM segments that the
31	Transponder can deliver in response to a single requesting
32	Interrogation (UF = 24). (see 14)
33	Aircraft identification capability (see 11)
34	Squitter capability subfield (SCS) (see 5)
35	Surveillance identifier code (SIC) (see 6)
36	Common usage GICB capability report (see 7)
37	
38	RESERVED FOR TCAS/ACAS (see 16, 17 and 18)
39	
40	
41	MSB
42	
43	
44	
45	
46	
47	Bit array indicating the support status of DTE
48	subaddresses 0 to 15 (see 3 and 8)
49	
50	
51	
52	
53	
54	
55	
56	LSB

PURPOSE: To report the data link capability of the Mode S transponder / data link installation.

The coding of this Register shall conform to:

1) Annex 10 Volume IV, §3.1.2.6.10.2.

2) When bit 25 is set to 1, it shall indicate that at least one Mode-S specific service (other than GICB services related to registers 02_{16}, 03_{16}, 04_{16}, 10_{16}, 17_{16} to $1C_{16}$, 20_{16} and 30_{16}) is supported and the particular capability reports shall be checked.

Note: *Registers accessed by BDS Codes 0,2; 0,3; 0,4; 1,0; 1,7 to 1,C; 2,0 and 3,0 do not affect the setting of bit 25.*

3) Starting from the MSB, each subsequent bit position shall represent the DTE subaddress in the range from 0 to 15.

4) The enhanced protocol indicator shall denote a Level 5 transponder when set to 1, and a Level 2 to 4 transponder when set to 0.

5) The squitter capability subfield (SCS) shall be set to 1 if both Registers 05_{16} and 06_{16} have been updated within the last ten, plus or minus one, seconds. Otherwise, it shall be set to ZERO (0).

Note: *Registers 05_{16} and 06_{16} are used for the extended squitter Airborne and surface position reports, respectively.*

6) The surveillance identifier code (SIC) bit shall be interpreted as follows:

0 = no surveillance identifier code capability
1 = surveillance identifier code capability

7) Bit 36 shall be toggled each time the common usage GICB capability report (Register 17_{16}) changes. To avoid the generation of too many broadcast capability report changes, Register 17_{16} shall be sampled at approximately one minute intervals to check for changes.

8) The current status of the on-board DTE shall be periodically reported to the GDLP by on-board sources. Since a change in this field results in a broadcast of the capability report, status inputs shall be sampled at approximately one minute intervals.

9) In order to determine the extent of any continuation of the data link capability report (into those registers reserved for this purpose: Register 11_{16} to Register 16_{16}), bit 9 shall be reserved as a continuation flag to indicate if the subsequent Register shall be extracted. For example: upon detection of bit 9 = 1 in Register 10_{16}, then Register 11_{16} shall be extracted. If bit 9 = 1, in Register 11_{16}, then Register 12_{16} shall be extracted, and so on (up to Register 16_{16}). Note that if bit 9 = 1 in Register 16_{16}, then this shall be considered as an error condition.

(Requirements are continued on the next page)

Table B-3-16: BDS Code 1,0 – Data Link Capability Report (concluded)

10) The Mode-S transponder may update bits 1-8, 16, 33, 35 and 37-40 independent of the ADLP. These bits are provided by the transponder when the data link capability report is broadcast as a result of a transponder detected change in capability reported by the ADLP (§3.1.2 of Annex 10 Volume IV).

11) Bit 33 indicates the availability of Aircraft Identification data. It shall be set by the transponder if the data comes to the transponder through a separate interface and not through the ADLP.

12) The Mode-S Subnetwork Version Number shall be coded as follows:

Version Number	Annex 10 amendment (Year and Edition)		RTCA	EUROCAE
0	Mode-S subnetwork not available			
1	1996	---		
2	1998	---		
3	2002	---		
4	2007	Doc 9871, Edition 1	DO-181D	ED-73C
5 - 127	Unassigned			

13) Uplink ELM average throughput capability shall be coded as follows:

0 = No UELM Capability
1 = 16 UELM segments in 1 second
2 = 16 UELM segments in 500 ms
3 = 16 UELM segments in 250 ms
4 = 16 UELM segments in 125 ms
5 = 16 UELM segments in 60 ms
6 = 16 UELM segments in 30 ms
7 = Unassigned

14) Downlink ELM throughput capability shall be coded as follows:

0 = No DELM Capability
1 = One 4 segment DELM every second
2 = One 8 segment DELM every second
3 = One 16 segment DELM every second
4 = One 16 segment DELM every 500 ms
5 = One 16 segment DELM every 250 ms
6 = One 16 segment DELM every 125 ms
7-15 = Unassigned

15) Bit 16 shall be set to ONE (1) to indicate that the transponder TCAS interface is operational and the transponder is receiving TCAS RI=2, 3 or 4.

16) Bit 37 shall be set to ONE (1) to indicate the capability of Hybrid Surveillance, and set to ZERO (0) to indicate that there is no Hybrid Surveillance capability.

17) Bit 38 shall be set to ONE (1) to indicate that the TCAS is generating both TAs and RAs, and set to ZERO (0) to indicate the generation of TAs only.

18)

Bit 40	Bit 39	Meaning
0	0	DO-185 (6.04A)
0	1	DO-185A
1	0	DO-185B
1	1	For future versions or enhancements (see Registers $E5_{16}$ and $E6_{16}$)

Note: *Additional implementation guidelines are provided in §B.4.1 of this Appendix.*

Table B-3-23: BDS Code 1,7 – Common Usage GICB Capability Report

MB FIELD

1	0,5 Extended Squitter Airborne Position
2	0,6 Extended Squitter Surface Position
3	0,7 Extended Squitter Status
4	0,8 Extended Squitter Type and Identification
5	0,9 Extended Squitter Airborne Velocity Information
6	0,A Extended Squitter Event-Driven Information
7	2,0 Aircraft identification
8	2,l Aircraft registration number
9	4,0 Selected vertical intention
10	4,l Next waypoint identifier
11	4,2 Next waypoint position
12	4,3 Next waypoint information
13	4,4 Meteorological routine report
14	4,5 Meteorological hazard report
15	4.8 VHF channel report
16	5,0 Track and turn report
17	5,1 Position coarse
18	5,2 Position fine
19	5,3 Air-referenced state vector
20	5,4 Waypoint 1
21	5,5 Waypoint 2
22	5,6 Waypoint 3
23	5,F Quasi-static parameter monitoring
24	6,0 Heading and speed report
25	Reserved for aircraft capability
26	Reserved for aircraft capability
27	E,1 Reserved for Mode S BITE (Built In Test Equipment)
28	E,2 Reserved for Mode S BITE (Built In Test Equipment)
29	F,1 Military applications
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	RESERVED
43	
44	
45	
46	
47	
48	
49	
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51	
52	
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54	
55	
56	

PURPOSE: To indicate common usage GICB services currently Supported.

1) Each bit position shall indicate that the associated Register is available in the aircraft installation when set to ONE (1).

2) All Registers shall be constantly monitored at a rate consistent with their individual required update rate and the corresponding capability bit shall be set to ONE (1) only when valid data is being input to that Register at the required rate or above.

3) The capability bit shall be set to a ONE (1) if at least one field in the Register is receiving valid data at the required rate with the status bits for all fields not receiving valid data at the required rate set to ZERO (0).

4) Registers 18_{16} to $1C_{16}$ shall be independent of Register 17_{16}.

Table B-3-24: BDS Code 1,8 – MSSS GICB Capability Report (1 of 5)

MB FIELD

1	BDS 3,8
2	BDS 3,7
3	BDS 3,6
4	BDS 3,5
5	BDS 3,4
6	BDS 3,3
7	BDS 3,2
8	BDS 3,1
9	BDS 3,0
10	BDS 2,F
11	BDS 2,E
12	BDS 2,D
13	BDS 2,C
14	BDS 2,B
15	BDS 2,A
16	BDS 2,9
17	BDS 2,8
18	BDS 2,7
19	BDS 2,6
20	BDS 2,5
21	BDS 2,4
22	BDS 2,3
23	BDS 2,2
24	BDS 2,1
25	BDS 2,0
26	BDS 1,F
27	BDS 1,E
28	BDS 1,D
29	BDS 1,C
30	BDS 1,B
31	BDS 1,A
32	BDS 1,9
33	BDS 1,8
34	BDS 1,7
35	BDS 1,6
36	BDS 1,5
37	BDS 1,4
38	BDS 1,3
39	BDS 1,2
40	BDS 1,1
41	BDS 1,0
42	BDS 0,F
43	BDS 0,E
44	BDS 0,D
45	BDS 0,C
46	BDS 0,B
47	BDS 0,A
48	BDS 0,9
49	BDS 0,8
50	BDS 0,7
51	BDS 0,6
52	BDS 0,5
53	BDS 0,4
54	BDS 0,3
55	BDS 0,2
56	BDS 0,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to ONE (1).

Starting from the LSB, each bit position shall represent the Register number, in accordance with the following table:

BDS Code	Capability installed for Register
BDS 1,8	01_{16} to 38_{16}
BDS 1,9	39_{16} to 70_{16}
BDS 1,A	71_{16} to $A8_{16}$
BDS 1,B	$A9_{16}$ to $E0_{16}$
BDS 1,C	$E1_{16}$ to FF_{16}

The 25 most significant bits of Register $1C_{16}$ shall not be used.

Table B-3-25: BDS Code 1,9 – MSSS GICB Capability Report (2 of 5)

MB FIELD

1	BDS 7,0
2	BDS 6,F
3	BDS 6,E
4	BDS 6,D
5	BDS 6,C
6	BDS 6,B
7	BDS 6,A
8	BDS 6,9
9	BDS 6,8
10	BDS 6,7
11	BDS 6,6
12	BDS 6,5
13	BDS 6,4
14	BDS 6,3
15	BDS 6,2
16	BDS 6,1
17	BDS 6,0
18	BDS 5,F
19	BDS 5,E
20	BDS 5,D
21	BDS 5,C
22	BDS 5,B
23	BDS 5,A
24	BDS 5,9
25	BDS 5,8
26	BDS 5,7
27	BDS 5,6
28	BDS 5,5
29	BDS 5,4
30	BDS 5,3
31	BDS 5,2
32	BDS 5,1
33	BDS 5,0
34	BDS 4,F
35	BDS 4,E
36	BDS 4,D
37	BDS 4,C
38	BDS 4,B
39	BDS 4,A
40	BDS 4,9
41	BDS 4,8
42	BDS 4,7
43	BDS 4,6
44	BDS 4,5
45	BDS 4,4
46	BDS 4,3
47	BDS 4,2
48	BDS 4,1
49	BDS 4,0
50	BDS 3,F
51	BDS 3,E
52	BDS 3,D
53	BDS 3,C
54	BDS 3,B
55	BDS 3,A
56	BDS 3,9

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to ONE (1).

Table B-3-26: BDS Code 1,A – MSSS GICB Capability Report (3 of 5)

MB FIELD

1	BDS A,8
2	BDS A,7
3	BDS A,6
4	BDS A,5
5	BDS A,4
6	BDS A,3
7	BDS A,2
8	BDS A,1
9	BDS A,0
10	BDS 9,F
11	BDS 9,E
12	BDS 9,D
13	BDS 9,C
14	BDS 9,B
15	BDS 9,A
16	BDS 9,9
17	BDS 9,8
18	BDS 9,7
19	BDS 9,6
20	BDS 9.5
21	BDS 9,4
22	BDS 9,3
23	BDS 9,2
24	BDS 9,1
25	BDS 9,0
26	BDS 8,F
27	BDS 8,E
28	BDS 8,D
29	BDS 8,C
30	BDS 8,B
31	BDS 8,A
32	BDS 8,9
33	BDS 8,8
34	BDS 8,7
35	BDS 8,6
36	BDS 8,5
37	BDS 8,4
38	BDS 8,3
39	BDS 8,2
40	BDS 8,1
41	BDS 8,0
42	BDS 7,F
43	BDS 7,E
44	BDS 7,D
45	BDS 7,C
46	BDS 7,B
47	BDS 7,A
48	BDS 7,9
49	BDS 7,8
50	BDS 7,7
51	BDS 7,6
52	BDS 7,5
53	BDS 7,4
54	BDS 7,3
55	BDS 7,2
56	BDS 7,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to ONE (1).

Table B-3-27: BDS Code 1,B – MSSS GICB Capability Report (4 of 5)

MB FIELD

1	BDS E,0
2	BDS D,F
3	BDS D,E
4	BDS D,D
5	BDS D,C
6	BDS D,B
7	BDS D,A
8	BDS D,9
9	BDS D,8
10	BDS D,7
11	BDS D,6
12	BDS D,5
13	BDS D,4
14	BDS D,3
15	BDS D,2
16	BDS D,1
17	BDS D,0
18	BDS C,F
19	BDS C,E
20	BDS C,D
21	BDS C,C
22	BDS C,B
23	BDS C,A
24	BDS C,9
25	BDS C,8
26	BDS C,7
27	BDS C,6
28	BDS C,5
29	BDS C,4
30	BDS C,3
31	BDS C,2
32	BDS C,1
33	BDS C,0
34	BDS B,F
35	BDS B,E
36	BDS B,D
37	BDS B,C
38	BDS B,B
39	BDS B,A
40	BDS B,9
41	BDS B,8
42	BDS B,7
43	BDS B,6
44	BDS B,5
45	BDS B,4
46	BDS B.3
47	BDS B,2
48	BDS B,1
49	BDS B,0
50	BDS A,F
51	BDS A,E
52	BDS A,D
53	BDS A,C
54	BDS A,B
55	BDS A,A
56	BDS A,9

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to ONE (1).

Table B-3-28: BDS Code 1,C – MSSS GICB Capability Report (5 of 5)

MB FIELD

1 2 3 4 5 6 7 8	
9 10 11 12 13 14 15 16	RESERVED
17 18 19 20 21 22 23 24	
25	
26	BDS F,F
27	BDS F,E
28	BDS F,D
29	BDS F,C
30	BDS F,B
31	BDS F,A
32	BDS F,9
33	BDS F,8
34	BDS F,7
35	BDS F,6
36	BDS F,5
37	BDS F,4
38	BDS F,3
39	BDS F,2
40	BDS F,1
41	BDS F,0
42	BDS E,F
43	BDS E,E
44	BDS E,D
45	BDS E,C
46	BDS E,B
47	BDS E,A
48	BDS E,9
49	BDS E,8
50	BDS E,7
51	BDS E,6
52	BDS E,5
53	BDS E,4
54	BDS E,3
55	BDS E,2
56	BDS E,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to ONE (1).

Table B-3-29: BDS Code 1,D – MSSS MSP Capability Report (1 of 3)

MB FIELD

1	Uplink MSP Channel 1
2	Uplink MSP Channel 2
3	Uplink MSP Channel 3
4	Uplink MSP Channel 4
5	Uplink MSP Channel 5
6	Uplink MSP Channel 6
7	Uplink MSP Channel 7
8	Uplink MSP Channel 8
9	Uplink MSP Channel 9
10	Uplink MSP Channel 10
11	Uplink MSP Channel 11
12	Uplink MSP Channel 12
13	Uplink MSP Channel 13
14	Uplink MSP Channel 14
15	Uplink MSP Channel 15
16	Uplink MSP Channel 16
17	Uplink MSP Channel 17
18	Uplink MSP Channel 18
19	Uplink MSP Channel 19
20	Uplink MSP Channel 20
21	Uplink MSP Channel 21
22	Uplink MSP Channel 22
23	Uplink MSP Channel 23
24	Uplink MSP Channel 24
25	Uplink MSP Channel 25
26	Uplink MSP Channel 26
27	Uplink MSP Channel 27
28	Uplink MSP Channel 28
29	Downlink MSP Channel 1
30	Downlink MSP Channel 2
31	Downlink MSP Channel 3
32	Downlink MSP Channel 4
33	Downlink MSP Channel 5
34	Downlink MSP Channel 6
35	Downlink MSP Channel 7
36	Downlink MSP Channel 8
37	Downlink MSP Channel 9
38	Downlink MSP Channel 10
39	Downlink MSP Channel 11
40	Downlink MSP Channel 12
41	Downlink MSP Channel 13
42	Downlink MSP Channel 14
43	Downlink MSP Channel 15
44	Downlink MSP Channel 16
45	Downlink MSP Channel 17
46	Downlink MSP Channel 18
47	Downlink MSP Channel 19
48	Downlink MSP Channel 20
49	Downlink MSP Channel 21
50	Downlink MSP Channel 22
51	Downlink MSP Channel 23
52	Downlink MSP Channel 24
53	Downlink MSP Channel 25
54	Downlink MSP Channel 26
55	Downlink MSP Channel 27
56	Downlink MSP Channel 28

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to ONE (1).

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-30: BDS Code 1,E – MSSS MSP Capability Report (2 of 3)

MB FIELD

1	Uplink MSP Channel 29
2	Uplink MSP Channel 30
3	Uplink MSP Channel 31
4	Uplink MSP Channel 32
5	Uplink MSP Channel 33
6	Uplink MSP Channel 34
7	Uplink MSP Channel 35
8	Uplink MSP Channel 36
9	Uplink MSP Channel 37
10	Uplink MSP Channel 38
11	Uplink MSP Channel 39
12	Uplink MSP Channel 40
13	Uplink MSP Channel 41
14	Uplink MSP Channel 42
15	Uplink MSP Channel 43
16	Uplink MSP Channel 44
17	Uplink MSP Channel 45
18	Uplink MSP Channel 46
19	Uplink MSP Channel 47
20	Uplink MSP Channel 48
21	Uplink MSP Channel 49
22	Uplink MSP Channel 50
23	Uplink MSP Channel 51
24	Uplink MSP Channel 52
25	Uplink MSP Channel 53
26	Uplink MSP Channel 54
27	Uplink MSP Channel 55
28	Uplink MSP Channel 56
29	Downlink MSP Channel 29
30	Downlink MSP Channel 30
31	Downlink MSP Channel 31
32	Downlink MSP Channel 32
33	Downlink MSP Channel 33
34	Downlink MSP Channel 34
35	Downlink MSP Channel 35
36	Downlink MSP Channel 36
37	Downlink MSP Channel 37
38	Downlink MSP Channel 38
39	Downlink MSP Channel 39
40	Downlink MSP Channel 40
41	Downlink MSP Channel 41
42	Downlink MSP Channel 42
43	Downlink MSP Channel 43
44	Downlink MSP Channel 44
45	Downlink MSP Channel 45
46	Downlink MSP Channel 46
47	Downlink MSP Channel 47
48	Downlink MSP Channel 48
49	Downlink MSP Channel 49
50	Downlink MSP Channel 50
51	Downlink MSP Channel 51
52	Downlink MSP Channel 52
53	Downlink MSP Channel 53
54	Downlink MSP Channel 54
55	Downlink MSP Channel 55
56	Downlink MSP Channel 56

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to ONE (1).

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-31: BDS Code 1,F – MSSS MSP Capability Report (3 of 3)

MB FIELD

1	Uplink MSP Channel 57
2	Uplink MSP Channel 58
3	Uplink MSP Channel 59
4	Uplink MSP Channel 60
5	Uplink MSP Channel 61
6	Uplink MSP Channel 62
7	Uplink MSP Channel 63
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	RESERVED
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	Downlink MSP Channel 57
30	Downlink MSP Channel 58
31	Downlink MSP Channel 59
32	Downlink MSP Channel 60
33	Downlink MSP Channel 61
34	Downlink MSP Channel 62
35	Downlink MSP Channel 63
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	RESERVED
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to ONE (1).

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-32: BDS Code 2,0 – Aircraft Identification (§2.2.19.1.13)

MB FIELD

1	MSB	
2		
3		
4	BDS Code 2,0	
5		
6		
7		
8	LSB	
9	MSB	
10		
11		CHARACTER 1
12		
13		
14	LSB	
15	MSB	
16		
17		CHARACTER 2
18		
19		
20	LSB	
21	MSB	
22		
23		CHARACTER 3
24		
25		
26	LSB	
27	MSB	
28		
29		
30		CHARACTER 4
31		
32	LSB	
33	MSB	
34		
35		
36		CHARACTER 5
37		
38	LSB	
39	MSB	
40		
41		
42		CHARACTER 6
43		
44	LSB	
45	MSB	
46		
47		
48		CHARACTER 7
49		
50	LSB	
51	MSB	
52		
53		
54		CHARACTER 8
55		
56	LSB	

PURPOSE: To report aircraft identification to the ground.

1) See Annex 10, Volume IV, §3.1.2.9.

2) The character coding to be used shall be identical to that defined in Table B-2-2 of this Appendix.

3) This data may be input to the transponder from sources other than the Mode-S ADLP.

4) Characters 1 – 8 of this format shall be used by the Extended Squitter application.

5) Capability to support this Register shall be indicated by setting bit 33 in Register 10_{16} and the relevant bits in Registers 17_{16} and 18_{16}.

6) The aircraft identification shall be that employed in the flight plan. When no flight plan is available, the registration marking of the aircraft shall be used.

Note: *Additional implementation guidelines are provided in §B.4.3 of this Appendix.*

Table B-3-33: BDS Code 2,1 –Aircraft and Airline Registration Markings

MB FIELD

1	STATUS	
2	MSB	
3		
4	CHARACTER 1	
5		
6		
7	LSB	
8	MSB	
9		
10	CHARACTER 2	
11		
12		
13	LSB	
14	MSB	
15		
16	CHARACTER 3	
17		
18		
19	LSB	
20	MSB	
21		
22	CHARACTER 4	AIRCRAFT
23		REGISTRATION
24		NUMBER
25	LSB	
26	MSB	
27		
28	CHARACTER 5	
29		
30		
31	LSB	
32	MSB	
33		
34	CHARACTER 6	
35		
36		
37	LSB	
38	MSB	
39		
40	CHARACTER 7	
41		
42		
43	LSB	
44	STATUS	
45	MSB	
46		
47	CHARACTER 1	
48		
49		
50	LSB	ICAO AIRLINE
51	MSB	REGISTRATION
52		MARKING
53	CHARACTER 2	
54		
55		
56	LSB	

PURPOSE: To permit ground systems to identify the aircraft without the necessity of compiling and maintaining continuously updated data banks.

The character coding shall be as defined in Table B-2-2 of this Appendix.

Table B-3-34: BDS Code 2,2 –Antenna Positions

MB FIELD

1	MSB	
2	ANTENNA TYPE	
3	LSB	
4	MSB = 32 meters	
5		
6	X POSITION	
7	Range = [1, 63]	ANTENNA 1
8		
9	LSB = 1 meter	
10	MSB = 16 meters	
11		
12	Z POSITION	
13	Range = [1, 31]	
14	LSB = 1 meter	
15	MSB	
16	ANTENNA TYPE	
17	LSB	
18	MSB = 32 meters	
19		
20	X POSITION	
21	Range = [1, 63]	ANTENNA 2
22		
23	LSB = 1 meter	
24	MSB = 16 meters	
25		
26	Z POSITION	
27	Range = [1, 31]	
28	LSB = 1 meter	
29	MSB	
30	ANTENNA TYPE	
31	LSB	
32	MSB = 32 meters	
33		
34	X POSITION	
35	Range = [1, 63]	ANTENNA 3
36		
37	LSB = 1 meter	
38	MSB = 16 meters	
39		
40	Z POSITION	
41	Range = [1, 31]	
42	LSB = 1 meter	
43	MSB	
44	ANTENNA TYPE	
45	LSB	
46	MSB = 32 meters	
47		
48	X POSITION	
49	Range = [1, 63]	ANTENNA 4
50		
51	LSB = 1 meter	
52	MSB = 16 meters	
53		
54	Z POSITION	
55	Range = [1, 31]	
56	LSB = 1 meter	

PURPOSE: To provide information on the position of Mode-S and GNSS antennas on the aircraft in order to make very accurate Measurements of aircraft position possible.

1) The antenna type field shall be interpreted as follows:

   0 = Invalid
   1 = Mode-S bottom antenna
   2 = Mode-S top antenna
   3 = GNSS antenna
   4 to 7 = Reserved

2) The X position field shall be the distance in meters along the aircraft center line measured from the nose of the aircraft. The field shall be interpreted as invalid if the value is ZERO (0) and the value of 63 shall mean that the antenna position is 63 meters or more from the nose.

3) The Z position field shall be the distance in meters of the antenna from the ground, measured with the aircraft unloaded and on the ground. The field shall be interpreted as invalid if the value is ZERO (0), and the value of 31 shall mean that the antenna position is 31 meters or more from the ground.

Table B-3-37: BDS Code 2,5 –Aircraft Type

MB FIELD

1	MSB	
2		
3	AIRCRAFT TYPE	
4		
5		
6	LSB	
7	MSB	
8	NUMBER OF ENGINES	
9	LSB	
10	MSB	
11		
12	ENGINE TYPE	
13		
14		
15	LSB	
16	MSB	
17		
18	CHARACTER 1	
19		
20		
21	LSB	
22	MSB	
23		
24	CHARACTER 2	
25		
26		
27	LSB	
28	MSB	
29		
30	CHARACTER 3	MODEL DESIGNATION
31		
32		
33	LSB	
34	MSB	
35		
36	CHARACTER 4	
37		
38		
39	LSB	
40	MSB	
41		
42	CHARACTER 5	
43		
44		
45	LSB	
46	MSB	
47		
48	WAKE TURBULENCE CATEGORY	
49		
50		
51	LSB	
52		
53		
54	RESERVED	
55		
56		

PURPOSE: To provide information on aircraft type.

1) Subfield coding

The coding shall be as in ICAO Doc 8643 – *Aircraft Type Designators.* All the subfields that contain characters shall be encoded using the 6-bit subset of IA-5 as specified in Table B-2-2 of this Appendix.

2) Model designation

Coding shall consist of four characters as specified in ICAO Doc 8643. The fifth character shall be reserved for future expansion and shall contain all ZEROs until it is specified. 2222 in the first four characters shall mean that the designator is not specified.

3) Number of engines

This subfield shall be encoded as a binary number where number 7 means 7 or more engines.

Table B-3-48: BDS Code 3,0 – TCAS/ACAS Active Resolution Advisory

MB FIELD

1	MSB	**PURPOSE:** To report resolution advisories (RAs) generated by TCAS/ACAS equipment.
2		
3		
4	BDS Code 3,0	The coding of this Register shall conform to:
5		
6		1) See §2.2.22.1.2.1.3.
7		
8	LSB	2) Bit 27 shall mean RA terminated when set to ONE (1).
9	MSB	
10		
11		
12		
13		
14		
15	ACTIVE RESOLUTION ADVISORIES	
16		
17		
18		
19		
20		
21		
22	LSB	
23	MSB	
24	RACs RECORD	
25		
26	LSB	
27	RA TERMINATED	
28	MULTIPLE THREAT ENCOUNTER	
29	MSB THREAT-TYPE INDICATOR	
30	LSB	
31	MSB	
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43	THREAT IDENTITY DATA	
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56	LSB	

Table B-3-64: BDS Code 4,0 – Selected Vertical Intention

MB FIELD

1	STATUS	
2	MSB = 32768 feet	
3		
4		
5	MCP/FCU SELECTED ALTITUDE	
6		
7	Range = [0, 65520] feet	
8		
9		
10		
11		
12		
13	LSB = 16 feet	
14	STATUS	
15	MSB = 32768 feet	
16		
17		
18	FMS SELECTED ALTITUDE	
19		
20	Range = [0, 65520] feet	
21		
22		
23		
24		
25		
26	LSB = 16 feet	
27	STATUS	
28	MSB = 204.8 mb	
29		
30		
31		
32	BAROMETRIC PRESSURE SETTING	
33	MINUS 800 mb	
34		
35	Range = [0, 410] mb	
36		
37		
38		
39	LSB = 0.1 mb	
40		
41		
42		
43		
44	RESERVED	
45		
46		
47		
48	STATUS OF MCP/FCU MODE BITS	
49	VNAV MODE	
50	ALT HOLD MODE	MCP/FCU Mode bits
51	APPROACH MODE	
52	RESERVED	
53		
54	STATUS OF TARGET ALT SOURCE BITS	
55	MSB TARGET ALT SOURCE	
56	LSB	

PURPOSE: To provide ready access to information about the aircraft's current vertical intentions, in order to improve the effectiveness of conflict probes and to provide additional tactical information to controllers.

1) Target altitude shall be the short-term intent value, at which the aircraft will level off (or has leveled off) at the end of the current maneuver. The data source that the aircraft is currently using to determine the target altitude shall be indicated in the altitude source bits (54 to 56) as detailed below.

   Note: *This information which represents the real "aircraft intent," when available, represented by the altitude control panel selected altitude, the flight management system selected altitude, or the current aircraft altitude according to the aircraft's mode of flight (the intent may not be available at all when the pilot is flying the aircraft).*

2) The data entered into bits 1 to 13 shall be derived from the mode control panel/flight control unit or equivalent equipment. Alerting devices may be used to provide data if it is not available from "control" equipment. The associated mode bits for this field (48 to 51) shall be as detailed below.

3) The data entered into bits 14 to 26 shall de derived from the flight management system or equivalent equipment managing the vertical profile of the aircraft.

4) The current barometric pressure setting shall be calculated from the value contained in the field (bits 28 to 39) plus 800 mb. When the barometric pressure setting is less than 800 mb or greater than 1209.5 mb, the status bit for this field (bit 27) shall be set to indicate invalid data.

5) Bits 48 to 56 shall indicate the status of the values provided in bits 1 to 26 as follows:

   Bit 48 shall indicate whether the mode bits (49, 50 and 51) are already being populated:

   0 = No mode information provided
   1 = Mode information deliberately provided

   Bits 49, 50 and 51:

   0 = Not active
   1 = Active

   Bit 54 shall indicate whether the target altitude source bits (55 and 56) are actively being populated:

   0 = No source information provided
   1 = Source information deliberately provided

   Bits 55 and 56 shall indicate target altitude source:

   00 = Unknown
   01 = Aircraft altitude
   10 = FCU/MCP selected altitude
   11 = FMS selected altitude

Note: *Additional implementation guidelines are provided in §B.4.4 of this Appendix.*

Table B-3-65: BDS Code 4,1 – Next Waypoint Details

MB FIELD

1	STATUS	
2	MSB	
3		
4		CHARACTER 1
5		
6		
7	LSB	
8	MSB	
9		
10		CHARACTER 2
11		
12		
13	LSB	
14	MSB	
15		
16		CHARACTER 3
17		
18		
19	LSB	
20	MSB	
21		
22		CHARACTER 4
23		
24		
25	LSB	
26	MSB	
27		
28		CHARACTER 5
29		
30		
31	LSB	
32	MSB	
33		
34		CHARACTER 6
35		
36		
37	LSB	
38	MSB	
39		
40		CHARACTER 7
41		
42		
43	LSB	
44	MSB	
45		
46		CHARACTER 8
47		
48		
49	LSB	
50	MSB	
51		
52		CHARACTER 9
53		
54		
55	LSB	
56	RESERVED	

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

1) Each character shall be encoded as specified in Table B-2-2.

Table B-3-66: BDS Code 4,2 – Next Waypoint Details

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	
7	
8	
9	WAYPOINT LATITUDE
10	
11	Range = [-180, +180] degrees
12	
13	
14	
15	
16	
17	
18	
19	
20	LSB = 90/131072 degrees
21	STATUS
22	SIGN
23	MSB = 90 degrees
24	
25	
26	
27	
28	
29	
30	WAYPOINT LONGITUDE
31	
32	Range = [-180, +180] degrees
33	
34	
35	
36	
37	
38	
39	
40	LSB = 90/131072 degrees
41	STATUS
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	WAYPOINT CROSSING
48	ALTITUDE
49	
50	Range = [-131072, +131064] feet
51	
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-67: BDS Code 4,3 – Next Waypoint Details

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	BEARING TO WAYPOINT
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 360/2048 degrees
13	STATUS
14	MSB = 204.8 minutes
15	
16	
17	
18	TIME TO GO
19	
20	Range = [0, 410] minutes
21	
22	
23	
24	
25	LSB = 0.1 minutes
26	STATUS
27	MSB = 3276.8 NM
28	
29	
30	
31	
32	
33	DISTANCE TO GO
34	
35	Range = [0, 6554] NM
36	
37	
38	
39	
40	
41	
42	LSB = 0.1 NM
43	
44	
45	
46	
47	
48	
49	
50	RESERVED
51	
52	
53	
54	
55	
56	

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

1) The bearing to waypoint is the bearing from the current aircraft heading position to the waypoint position referenced to true north.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-72: BDS Code 4,8 – VHF Channel Report

MB FIELD

1	MSB	
2		
3		
4		
5		
6		
7		
8		VHF 1
9		
10		
11		
12		
13		
14		
15	LSB	
16	STATUS	
17	MSB	VHF 1
18	LSB	AUDIO STATUS
19	MSB	
20		
21		
22		
23		
24		
25		
26		VHF 2
27		
28		
29		
30		
31		
32		
33	LSB	
34	STATUS	
35	MSB	VHF 2
36	LSB	AUDIO STATUS
37	MSB	
38		
39		
40		
41		
42		
43		VHF 3
44		
45		
46		
47		
48		
49		
50		
51	LSB	
52	STATUS	
53	MSB	VHF 3
54	LSB	AUDIO STATUS
55	MSB	121.5 MHz
56	LSB	AUDIO STATUS

PURPOSE: To allow the ATC system to monitor the settings of the VHF communications channel and to determine the manner in which each channel is being monitored by the aircrew.

Channel report coding:
Each VHF communications channel shall be determined form the 15-bit positive binary number, N in kHz, according to the formula:

Channel (MHz) = Base + N x 0.001 (MHz)

where: Base = 118.000 MHz

Notes:

1) The use of binary to define the channel improves the coding efficiency.
2) This coding is compatible with analogue channels on 25 kHz, 8.33 kHz channel spacing and VDL as described below.
3) VDL has a full four bits allocated such that the active status of each of its four multiplex channels can be ascertained.

25 kHz	**VDL: Mode 3**	**Analogue**
Bit		
16	Status	Status
15 (LSB)	MSB (12800 kHz)	MSB (12800 kHz)
	Range 118.000 to 143.575 136.975 (military use)	Range 118.000 to 143.575 136.975 (military use)
6	LSB (25 kHz)	LSB (25 kHz)
5	4 x channel active flags	Unused
4		Unused
3		Unused
2		8.33 indicator = 0
1 (MSB)	VDL indicator = 1	VDL indicator = 0

8.33 kHz	**Analogue**
Bit	
16	Status
15 (LSB)	MSB (17066 kHz)
…	Range 118.000 to 152.112 136.975 (military use)
4	LSB (17066/2048 kHz)
3	Unused
2	8.33 indicator = 1
1 (MSB)	VDL indicator = 0

Audio status coding:
Each pair of audio status bits shall be used to describe the aircrew Monitoring of that audio channel according to the following table:

Bit 1 (MSB)	**Bit 2 (LSB)**	
0	0	UNKNOWN
0	1	NOBODY
1	0	HEADPHONES ONLY
1	1	LOUDSPEAKER

Table B-3-80: BDS Code 5,0 – Track and Turn Report

MB FIELD

1	STATUS
2	SIGN 1 = Left Wing Down
3	MSB = 45 degrees
4	
5	
6	ROLL ANGLE
7	
8	Range = [-90, + 90] degrees
9	
10	
11	LSB = 45/256 degrees
12	STATUS
13	SIGN 1 = West (e.g., 315 = -45 degrees)
14	MSB = 90 degrees
15	
16	
17	TRUE TRACK ANGLE
18	
19	Range = [-180, +180] degrees
20	
21	
22	
23	LSB = 90/512 degrees
24	STATUS
25	MSB = 1024 knots
26	
27	
28	GROUND SPEED
29	
30	Range = [0, 2046] knots
31	
32	
33	
34	LSB = 1024/512 knots
35	STATUS
36	SIGN 1 = Minus
37	MSB = 8 degrees/second
38	
39	
40	TRACK ANGLE RATE
41	Range = [-16, +16] degrees/second
42	
43	
44	
45	LSB = 8/256 degrees/second
46	STATUS
47	MSB = 1024 knots
48	
49	
50	TRUE AIRSPEED
51	
52	Range = [0, 2046] knots
53	
54	
55	
56	LSB = 2 knots

PURPOSE: To provide track and turn data to the ground systems.

1) If the value of the parameter from any source exceeds the range allowable in the Register definition, the maximum allowable value in the correct positive or negative sense shall be used instead.

   Note 1: *This requires active intervention by the GFM.*

2) The data entered into the Register shall, whenever possible, be derived from the sources that are controlling the aircraft.

3) If any parameter is not available on the aircraft, all bits corresponding to that parameter shall be actively set to ZERO (0) by the GFM.

4) The LSB of all fields shall be obtained by rounding.

Note 2: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Note 3: *Additional implementation guidelines are provided in §B.4.5 of this Appendix.*

Table B-3-81: BDS Code 5,1 – Position Report Coarse

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	
7	
8	
9	LATITUDE
10	
11	Range = [-180, +180] degrees
12	(see 2)
13	
14	
15	
16	
17	
18	
19	
20	
21	LSB = 360/1048576 degrees
22	SIGN
23	MSB = 90 degrees
24	
25	
26	
27	
28	LONGITUDE
29	
30	Range = [-180, +180] degrees
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	LSB = 360/1048576 degrees
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	PRESSURE
48	ALTITUDE
49	
50	Range = [-1000, +126752] feet
51	
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide a three-dimensional report of aircraft position.

1) The single status bit (bit 1) shall be set to ZERO (0) if any of the three parameters is invalid. This bit shall be identical to the status bit in Register 52_{16}.

2) The required valid range for latitude is +90 degrees to -90 degrees, but the parameter shall be coded with an MSB of 90 degrees to allow the use of the same coding algorithm as for longitude.

3) The source of the information in this Register shall be the same as that indicated in the FOM/SOURCE field of Register 52_{16}.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-82: BDS Code 5,2 – Position Report Fine

MB FIELD

1	STATUS (see 1)
2	MSB
3	FOM/SOURCE
4	
5	LSB
6	MSB = 90/128 degrees
7	
8	
9	
10	
11	
12	
13	LATITUDE FINE
14	
15	Range = [0, 180/128] degrees
16	
17	
18	
19	
20	
21	
22	
23	LSB = 90/16777216 degrees
24	MSB = 90/128 degrees
25	
26	
27	
28	
29	
30	
31	LONGITUDE FINE
32	
33	Range = [0, 180/128] degrees
34	
35	
36	
37	
38	
39	
40	
41	LSB = 90/16777216 degrees
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	PRESSURE ALTITUDE
48	OR
49	GNSS HEIGHT (HAE)
50	
51	Range = [-1000, +126752] feet
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide a high-precision three-dimensional report on aircraft position when used in conjunction with Register 51_{16}. information on the source of the data is included.

FOM/SOURCE Coding:
The decimal value of the binary-coded (Figure of Merit) FOM / SOURCE parameter shall be interpreted as follows:

0 = FOM > 10 NM or Unknown Accuracy
1 = FOM 10 NM/18.5 km (e.g., INS data) pressure altitude
2 = FOM 4 NM/7.4 km (e.g., VOR/DME) pressure altitude
3 = FOM 2 NM/3.7 km (e.g., DME/DME or GNSS) pressure altitude
4 = FOM 1 NM/1.85 km (e.g., DME/DME or GNSS) pressure altitude
5 = FOM 0.5 NM/926 m (e.g., DME/DME or GNSS) pressure altitude
6 = FOM 0.3 NM/556 m (e.g., DME/DME or GNSS) pressure altitude
7 = FOM 0.1 NM/185.2 m (ILS, MLS or differential GNSS) pressure altitude
8 = FOM 0.05 NM/92.6 m (ILS, MLS or differential GNSS) pressure altitude
9 = FOM 30 m (ILS, MLS or differential GNSS) pressure altitude
10 = FOM 10 m (ILS, MLS or differential GNSS) pressure altitude
11 = FOM 3 m (ILS, MLS or differential GNSS) pressure altitude
12 = FOM 30 m (ILS, MLS or differential GNSS) GNSS height
13 = FOM 10 m (ILS, MLS or differential GNSS) GNSS height
14 = FOM 3 m (ILS, MLS or differential GNSS) GNSS height
15 = Reserved

Note 1: *When GNSS is the source, then the FOM is encoded by the HFOM parameter. When RNP FMS is the source, the FOM is encoded by the ANP.*

1) The single status bit (bit 1) shall be set to ZERO (0) if any of the three parameters are invalid and is identical to the status bit in Register 51_{16}.

2) The LATITUDE (fine) and LONGITUDE (fine) parameters are in 2's complement coding so they shall be interpreted in conjunction with the corresponding parameters in Register 51_{16}.

3) When GNSS height is contained in bits 42 to 56, the pressure altitude can be obtained from Register 51_{16}.

Note 2: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Note 3: *The Figure of Merit selected is the smallest number that encompasses the HFOM or the ANP.*

Table B-3-83: BDS Code 5,3 – Air-Referenced State Vector

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	MAGNETIC HEADING
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 90/512 degrees
13	STATUS
14	MSB = 512 knot
15	
16	
17	INDICATED AIRSPEED (IAS)
18	
19	Range = [0, 1023] knots
20	
21	
22	
23	LSB = 1 knot
24	STATUS
25	MSB = MACH 2.048
26	
27	
28	MACH NUMBER
29	
30	Range = [0, 4.096] MACH
31	
32	
33	LSB = MACH 0.008
34	STATUS
35	MSB = 1024 knots
36	
37	
38	
39	
40	TRUE AIRSPEED
41	
42	Range = [0, 2048] knots
43	
44	
45	
46	LSB = 0.5 knots
47	STATUS
48	SIGN
49	MSB = 8192 feet/minute
50	
51	ALTITUDE RATE
52	
53	Range = [-16384, +16320] feet/minute
54	
55	
56	LSB = 64 feet/minute

PURPOSE: To provide the ATC system with current measured values of magnetic heading. IAS/MACH, altitude rate and TAS.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Table B-3-84 to B-3-86: BDS Codes 5,4 to 5,6 – Waypoints 1, 2 and 3

MB FIELD

1	STATUS (see 1)
2	MSB
3	
4	CHARACTER 1
5	
6	
7	LSB
8	MSB
9	
10	CHARACTER 2
11	
12	
13	LSB
14	MSB
15	
16	CHARACTER 3
17	
18	
19	LSB
20	MSB
21	
22	CHARACTER 4
23	
24	
25	LSB
26	MSB
27	
28	CHARACTER 5
29	
30	
31	LSB
32	MSB = 30 minutes
33	
34	ESTIMATED TIME OF ARRIVAL
35	(NORMAL FLIGHT)
36	
37	Range = [0, 60] minutes
38	
39	
40	LSB = 60/512 minutes
41	MSB = 320 FL
42	
43	ESTIMATED FLIGHT LEVEL
44	(NORMAL FLIGHT)
45	Range = [0, 630] FL
46	LSB = 10 FL
47	MSB = 30 minutes
48	
49	TIME TO GO
50	(DIRECT ROUTE)
51	
52	Range = [0, 60] minutes
53	
54	
55	LSB = 60/512 minutes
56	RESERVED

PURPOSE: To provide information on the next three waypoints,
Register 54_{16} contains information on the next waypoint,
Register 55_{16} contains information on the next waypoint plus one, and
Register 56_{16} contains information on the next waypoint plus two.

1) The single status bit shall be set to ZERO (0) if any of the parameters are invalid.

2) The actual time or flight level shall be calculated from the trajectory scheduled in the FMS.

   Note: *Mode detail on the next waypoint is given in Register 41_{16} to 43_{16}.*

3) When the waypoint identity has only three characters, two leading ZERO (0) characters shall be added (e.g., CDN becomes 00CDN).

4) Estimated time is in minutes, and ALL ONEs shall be used to indicate that the waypoint referred to is one hour or more away.

Table B-3-95: BDS Code 5,F – Quasi-Static Parameter Monitoring

MB FIELD

1	MSB	MCP/FCU SELECTED ALTITUDE
2	LSB	
3		RESERVED
4		
5		RESERVED
6		
7		RESERVED
8		
9		RESERVED
10		
11		RESERVED
12		
13	MSB	NEXT WAYPOINT
14	LSB	
15		RESERVED
16		
17	MSB	FMS VERTICAL MODE
18	LSB	
19	MSB	VHF CHANNEL REPORT
20	LSB	
21	MSB	METEOROLOGICAL HAZARDS
22	LSB	
23	MSB	FMS SELECTED ALTITUDE
24	LSB	
25	MSB	BAROMETRIC PRESSURE
26	LSB	SETTING MINUS 800 mb
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		RESERVED
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To permit the monitoring of changes in parameters that do not normally change very frequently, i.e., those expected to be stable for 5 minutes or more by accessing a single Register.

Parameter Monitor Coding:

1) The changing of each parameter shall be monitored by 2 bits. The value 00 shall indicate that no valid data are available on this parameter. The decimal value for this 2-bit field shall be cycled through 1, 2 and 3, each step indicating a change in the monitored parameter.

2) The meteorological hazards subfield shall report changes to turbulence, wind shear, wake vortex, icing and microburst, as in Register number 45_{16}.

3) The next waypoint subfield shall report change to data contained in Registers 41_{16}, 42_{16} and 43_{16}.

4) The FMS vertical mode shall report change to bits 48 to 51 in Register 40_{16}.

Table B-3-96: BDS Code 6,0 – Heading and Speed Report

MB FIELD

1	STATUS
2	SIGN 1=West (e.g., 315 = -45 degrees)
3	MSB = 90 degrees
4	
5	
6	MAGNETIC HEADING
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 90/512 degrees
13	STATUS
14	MSB = 512 knots
15	
16	
17	INDICATED AIRSPEED
18	
19	Range = [0, 1023] knots
20	
21	
22	
23	LSB = 1 knot
24	STATUS
25	MSB = 2.048 MACH
26	
27	
28	MACH
29	
30	Range = [0, 4.092] MACH
31	
32	
33	
34	LSB = 2.048/512 MACH
35	STATUS
36	SIGN 1=Below
37	MSB = 8192 feet/minute
38	
39	
40	BAROMETRIC ALTITUDE RATE
41	
42	Range = [-16384, +16352] feet/minute
43	
44	
45	LSB = 8192/256 = 32 feet/minute
46	STATUS
47	SIGN 1=Below
48	MSB = 8192 feet/minute
49	
50	
51	INERTIAL VERTICAL VELOCITY
52	
53	Range = [-16384, +16352] feet/minute
54	
55	
56	LSB = 8192/256 = 32 feet/minute

PURPOSE: To provide heading and speed data to ground systems.

1) If the value of a parameter from any source exceeds the range allowable in the Register definition, the maximum allowable value in the correct positive or negative sense shall be used instead.

Note 1: *This requires active intervention by the GFM.*

2) The data entered into the Register shall whenever possible be derived from the sources that are controlling the aircraft.

3) The LSB of all fields shall be obtained by rounding.

4) When barometric altitude rate is integrated and smoothed with inertial vertical velocity (baro-inertial information) it shall be transmitted in the Inertial Vertical Velocity field.

Note 2: *Barometric Altitude Rate contains values solely derived from barometric measurement. The Barometric Altitude Rate is usually very unsteady and may suffer from barometric instrument inertia.*

Note 3: *The Inertial Vertical Velocity is also providing information on vertical movement of the aircraft but it comes from equipments (IRS, AHRS) using different sources used for navigation. The information is a more filtered and smooth parameter.*

Note 4: *Two's complement coding is used for all signed fields as specified in §B.2.2.2 of this Appendix.*

Note 5: *Additional implementation guidelines are provided in §B.4.6 of this Appendix.*

Table B-3-97-1: BDS Code 6,1 – Aircraft Status
(Subtype 1: Emergency/Priority Status)

MB FIELD

1	MSB
2	
3	FORMAT TYPE CODE = 28
4	
5	LSB
6	MSB
7	SUBTYPE CODE = 1
8	LSB
9	MSB
10	EMERGENCY STATE
11	LSB
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	RESERVED
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	

PURPOSE: To provide additional information on aircraft status.

Subtype shall be coded as follows:

0 = No information
1 = Emergency/priority status
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state shall be coded as follows:

Value	Meaning
0	No emergency
1	General emergency
2	Lifeguard/Medical
3	Minimum fuel
4	No communications
5	Unlawful interference
6	Downed aircraft
7	Reserved

1) Message delivery shall be accomplished once per 0.8 seconds using the event-driven protocol.

2) Termination of emergency state shall be detected by coding in the surveillance status field of the airborne position message.

3) Subtype 2 message broadcast shall take priority over subtype 1 message broadcast.

4) Emergency State value 1 shall be set when Mode A code 7700 is provided to the transponder.

5) Emergency State value 4 shall be set when Mode A code 7600 is provided to the transponder.

6) Emergency State value 5 shall be set when Mode A code 7500 is provided to the transponder.

Table B-3-97-2: BDS Code 6,1– Aircraft Status
(Subtype 2: Extended Squitter TCAS RA Broadcast)

MB FIELD

1	MSB	
2		
3	FORMAT TYPE CODE = 28	
4		
5	LSB	
6	MSB	
7	SUBTYPE CODE = 2	
8	LSB	
9	MSB	
10		
11		
12		
13		
14		
15	ACTIVE RESOLUTION ADVISORIES	
16		
17		
18		
19		
20		
21		
22	LSB	
23	MSB	
24	RACs RECORD	
25		
26	LSB	
27	RA TERMINATED	
28	MULTIPLE THREAT ENCOUNTER	
29	MSB THREAT – TYPE INDICATOR	
30	LSB	
31	MSB	
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43	THREAT IDENTITY DATA	
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56	LSB	

PURPOSE: To report resolution advisories (RAs) generated by TCAS equipment.

Subtype shall be coded as follows:

0	=	No information
1	=	Emergency/priority status
2	=	TCAS RA Broadcast
3 to 7	=	Reserved

TCAS RA Broadcast shall be coded as follows:

The coding of bits 9 to 56 of this Register shall conform to the corresponding bits of Register 30_{16} as specified in Annex 10, Volume IV, §4.3.8.4.2.2.

1) Message delivery shall be accomplished once per 0.8 seconds using the event-driven protocol.

2) RA Broadcast shall begin within 0.5 seconds after transponder notification of the initiation of an TCAS RA.

3) RA Broadcast shall be terminated 10 seconds after the RAT flag (Annex 10, Volume IV, §4.3.8.4.2.2.1.3) transitions from ZERO to ONE.

4) Subtype 2 message broadcast shall take priority over subtype 1 message broadcast.

Table B-3-98: BDS Code 6,2 – Target State and Status Information

MB FIELD

1	FORMAT TYPE CODE = 29	
2		
3		
4		
5		
6	MSB	SUBTYPE CODE = 0
7	LSB	
8	MSB	Vertical Data Available / Source Indicator
9	LSB	
10	Target Altitude Type	
11	Backward Compatibility Flag = 0	
12	MSB	Target Altitude Capability
13	LSB	
14	MSB	Vertical Mode Indicator
15	LSB	
16	MSB	
17		
18		
19		
20	Target Altitude	
21		
22		
23		
24		
25	LSB	
26	MSB	Horizontal Data Available / Source Indicator
27	LSB	
28	MSB	
29		
30		
31		
32	Target Heading / Track Angle	
33		
34		
35		
36	LSB	
37	Target Heading / Track Indicator	
38	MSB	Horizontal Mode Indicator
39	LSB	
40	MSB	
41	Navigation Accuracy Category – Position (NAC_P)	
42		
43	LSB	
44	Navigation Integrity Category – Baro (NIC_{BARO})	
45	MSB	Surveillance Integrity Level (SIL)
46	LSB	
47		
48		
49	Reserved	
50		
51		
52	MSB	Capability / Mode Codes
53	LSB	
54	MSB	
55	Emergency / Priority Status	
56	LSB	

PURPOSE: To provide aircraft state and status information.

able B-3-101: BDS Code 6,5 – Extended Squitter Aircraft Operational Status

MB FIELD

1	MSB	
2		
3	FORMAT TYPE CODE = 31	
4		
5	LSB	
6	MSB	MSB
7	SUBTYPE CODE = 0	SUBTYPE CODE = 1
8	LSB	LSB
9	MSB	MSB
10		
11		
12		
13		
14	AIRBORNE	SURFACE
15	CAPABILITY CLASS (CC)	CAPABILITY CLASS (CC)
16	CODES	CODES
17		
18		
19		
20		LSB
21		MSB
22		LENGTH/WIDTH CODES
23		
24	LSB	LSB
25	MSB	
26		
27		
28		
29		
30		
31		
32	OPERATIONAL MODE (OM) CODES	
33		
34		
35		
36		
37		
38		
39		
40	LSB	
41	MSB	
42	VERSION NUMBER	
43	LSB	
44	NIC SUPPLEMENT	
45	MSB	
46	NAVIGATIONAL ACCURACY CATEGORY – POSITION	
47	(NAC_P)	
48	LSB	
49	MSB BAQ = 0	RESERVED
50	LSB	
51	MSB SURVEILLANCE INTEGRITY LEVEL (SIL)	
52	LSB	
53	NIC_{BARO}	TRK/HDG
54	HRD	
55	RESERVED	
56		

PURPOSE: To provide the capability class and current operational mode of ATC-related applications and other operational information..

Subtype Coding:

0 = Airborne Status Message
1 = Surface Status Message
2 – 7 = Reserved

1) Message delivery shall be accomplished using the event-driven protocol.

Table B-3-227: BDS Code E,3 – Transponder Type / Part Number

MB FIELD

1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide Mode-S transponder part number or type as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If the part number is not available, the first 8 characters of the commercial name can be used with the format type "01."

3) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-2. Character 1 is the first left character of the transponder type.

4) For operational reasons, some military installations may not implement this format.

Table B-3-228: BDS Code E,4 – Transponder Software Revision Number

MB FIELD

1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide Mode-S transponder software revision number as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When a part number is allocated to the software revision, it is recommended to use the format type "00." In this case, P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-2. Character 1 is the first left character of the software revision number.

3) For operational reasons, some military installations may not implement this format.

Table B-3-229: BDS Code E,5 – TCAS/ACAS Unit Part Number

MB FIELD

1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide TCAS/ACAS unit part number or type as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If the part number is not available, the first 8 characters of the commercial name can be used with the format type "01."

3) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-2. Character 1 is the first left character of the TCAS/ACAS unit type.

4) For operational reasons, some military installations may not implement this format.

Table B-3-230: BDS Code E,6 – TCAS/ACAS Unit Software Revision

MB FIELD

1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide TCAS/ACAS unit software revision number as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-2. Character 1 is the first left character of the TCAS/ACAS unit software revision.

3) For operational reasons, some military installations may not implement this format.

Table B-3-241: BDS Code F,1 – Military Applications

MB FIELD

1	STATUS	
2	Character Field (see 1)	
3	C1	
4	A1	
5	C2	
6	A2	
7	C4	
8	A4	MODE 1 CODE
9	X	
10	B1	
11	D1	
12	B2	
13	D2	
14	B4	
15	D4	
16	STATUS	
17	C1	
18	A1	
19	C2	
20	A2	
21	C4	
22	A4	MODE 2 CODE
23	X	
24	B1	
25	D1	
26	B2	
27	D2	
28	B4	
29	D4	
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		RESERVED
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To provide data in support of military applications.

1) The character field shall be used to indicate whether 2 characters or 4 characters are used in the Mode 1 code. The logic shall be as follows:

   0 = 2 octal codes
   (A1 – A4 and B1 – B4)

   1 = 4 octal codes
   (A1 – A4, B1 – B4, C1 – C4 and D1 – D4)

2) The status fields shall be used to indicate whether the data are available or unavailable. The logic shall be as follows:

   0 = Unavailable
   1 = Available

Table B-3-242: BDS Code F,2 – Military Applications

MB FIELD

1	MSB	
2		
3	AF=2, TYPE CODE = 1	
4		
5	LSB	
6	STATUS	
7	CHARACTER FIELD (see 1)	
8	C1	
9	A1	
10	C2	
11	A2	
12	C4	
13	A4	
14	X	MODE 1 CODE
15	B1	
16	D1	
17	B2	
18	D2	
19	B4	
20	D4	
21	STATUS	
22	C1	
23	A1	
24	C2	
25	A2	
26	C4	
27	A4	
28	X	MODE 2 CODE
29	B1	
30	D1	
31	B2	
32	D2	
33	B4	
34	D4	
35	STATUS	
36	C1	
37	A1	
38	C2	
39	A2	
40	C4	
41	A4	
42	X	MODE A CODE
43	B1	
44	D1	
45	B2	
46	D2	
47	B4	
48	D4	
49		
50		
51		
52		RESERVED
53		
54		
55		
56		

PURPOSE: This Register is used for military applications involving DF=19. Its purpose is to provide data in support of military applications.

'TYPE CODE' shall be encoded as follows:

0 = Unassigned
1 = Mode code information
2-31 = Unassigned

1) The character field shall be used to indicate whether 2 characters or 4 characters are used in the Mode 1 code. The logic shall be as follows:

0 = 2 octal codes
(A1 – A4 and B1 – B4)

1 = 4 octal codes
(A1 – A4, B1 – B4, C1 – C4 and D1 – D4)

2) The status fields shall be used to indicate whether the data are available or unavailable. The logic shall be as follows:

0 = Unavailable
1 = Available

DF = 19 Application Field (AF) shall be encoded as follows:

0 = Reserved for civil Extended Squitter formats
1 = Reserved for formation flight
2 = Reserved for military applications
3-7 = Reserved

B.4 Implementation Guidelines

This section provides implementation guidelines on data formats for applications using Mode S Specific Services contained in this Appendix. The section is intended for use by the avionics industry and by the developers of air traffic services (ATS) applications.

B.4.1 Transponder Register 10_{16} (ICAO Doc 9871, §C.2.4.1)

The following sections state the guidance material that apply for the setting of some specific bits of transponder Register 10_{16}.

B.4.1.1 Bit 9 (Continuation Flag)

This bit should be set as specified in Table B-3-16.

In order to determine the extent of any continuation of the data link capability report (into those Registers reserved for this purpose: Register 11_{16} to Register 16_{16}), bit 9 is reserved as a 'continuation flag' to indicate if the subsequent Register can be extracted. For example: upon detection of bit 9=1 in Register 10_{16} then Register 11_{16} can be extracted. If bit 9=1 in Register 11_{16} then Register 12_{16} can be extracted, and so on (up to Register 16_{16}). Note that if bit 9=1 in Register 16_{16} then this shall be considered as an error condition.

As long as transponder Registers 11_{16} to 16_{16} are undefined, bit 9 should be set to ZERO (0).

B.4.1.2 Bit 16 and Bits 37 – 40 (TCAS Bits)

The setting of these bits is dynamic. They are set by TCAS and possibly overwritten by the transponder.

These bits should be set as specified in Table B-3-16.

Bit 16 should be set to ONE (1) to indicate that the transponder TCAS interface is operational and the transponder is receiving TCAS RI=2, 3 or 4.

Bit 37 should be set to ONE (1) to indicate the capability of Hybrid Surveillance, and set to ZERO (0) to indicate that there is no Hybrid Surveillance capability.

Bit 38 should be set to ONE (1) to indicate that the TCAS is generating both TAs and RAs, and set to ZERO (0) to indicate the generation of TAs only.

Bits 39 and 40 should be set according to the TCAS version:

Bit 40	Bit 39	Meaning
0	0	DO-185 (6.04A)
0	1	DO-185A
1	0	DO-185B

1	1	For future versions or enhancements (see Registers $E5_{16}$ and $E6_{16}$)

B.4.1.3 Bits 17 – 23 (Mode S Subnetwork Version Number)

These bits should be set as specified in Table B-3-16.

17 – 23 Mode S Subnetwork Version Number.

0 = Mode S subnetwork not available
1 = Version No. 1 (1996)
2 = Version No. 2 (1998)
3 = Version No. 3 (2002)
4 = Version No. 4 (2007), ICAO 9871, Edition 1 ~~of this document~~
5-127 = Unassigned

The Mode S Subnetwork Version Number should be set to a non-zero value if at least one DTE or Mode S Specific Service is installed. For example, if Register 40_{16} is loaded with data, it means that the GICB service associated to Register 40_{16} is installed. In that case bits 17-23 will be set to a non zero value, e.g., value 3 if the format of Register 40_{16} meets the requirements of Amendment 77 (applicable in 2002).

If the installed DTE or the Mode S Specific Services meet the requirements of Amendment 71 (applicable in 1996) only, then the Mode S Subnetwork Version Number should be set to ONE (1).

If the installed DTE or the Mode S Specific Services meet the requirements of Amendment 73 (applicable in 1998) only and/or the transponder Register formats meet the requirements of ICAO Doc 9688 version 1, then the Mode S Subnetwork Version Number should be set to TWO (2).

If the installed DTE or the Mode S Specific Services meet the requirements of Amendment 77, then the Mode S Subnetwork Version Number should be set to THREE (3).

The setting of these bits is static.

B.4.1.4 Bit 24 (Transponder Enhanced Protocol Indicator)

This bit is set to ONE (1) when the transponder is a Level 5 Transponder. This bit is set by the Transponder itself. It is a static bit.

B.4.1.5 Bit 25 (Mode S Specific Services Capability)

This bit should be set as specified in Table B-3-16, item 2.

When Bit 25 is set to ONE (1), it indicates that at least one Mode S specific service is supported and the particular capability reports should be checked.

Note: *Registers accessed by BDS Codes 0,2; 0,3; 0,4; 1,0; 1,7 through 1,C; 2,0 and 3,0 do not affect the setting of Bit 25.*

This bit actually indicates if the aircraft installation enables the loading of airborne parameters in at least one register not accessed by the BDS Codes mentioned above.

The setting of this bit is preferably static.

B.4.1.6 Bits 26 – 32 (Uplink and Downlink ELM Throughput Capability)

Bits 26 – 28 indicate the uplink ELM average throughput capability. These bits are set by the transponder and are preferably static.

Bits 29 – 32 indicate the throughput capability of downlink ELM containing the maximum number of ELM segments that the transponder can deliver in response to an interrogation. These bits are set by the transponder and are preferably static.

B.4.1.7 Bit 33 (Aircraft Identification Capability)

This bit should be set as required in Annex 10, Volume IV, §3.1.2.9.1.3.

Aircraft identification capability report. Transponders which respond to a ground-initiated request for aircraft identification shall report this capability in the data link capability report (Annex 10, Volume IV, §3.1.2.6.10.2.2.) by setting Bit 33 of the MB subfield to ONE (1).

This bit actually indicates whether the aircraft installation supports an interface to load the aircraft identification into the transponder Register 20_{16}. It does not take into account the consistency of the data loaded into the Register.

The setting of this bit is preferably dynamic. In case it is statically handled it should be forced to ONE (1).

When this bit is dynamic, it is always equal to Bit 7 of Register 17_{16}. It might be different from Bit 25 of Register 18_{16} since the bits of Registers 18_{16} to $1C_{16}$ are not reset once they are set. If the interface availability changes during the flight Bit 33 of Register 10_{16} and Bit 7 of Register 17_{16} will be updated accordingly whereas Bit 25 of Register 18_{16} will remain unchanged.

Note 1: *The intent of the capability bits in Register 17_{16} is to indicate that useful data are contained in the corresponding transponder Register. For this reason, each bit for a Register is cleared if data becomes unavailable (see ICAO Doc 9871, §A.2.5.4.1) and set again when data insertion into the Register resumes.*

Note 2: *A bit set in Registers 18_{16} to $1C_{16}$ indicates that the application using this Register has been installed on the aircraft. These bits are not cleared to reflect the real-time loss of an application, as is done for Register 17_{16} (see ICAO Doc 9871, §A.2.5.4.2).*

It is also to be noted that Register 10_{16} will be broadcasted twice following the interface availability change. The first time because Bit 33 will change, then because Bit 36 will also toggle approximately one minute later to indicate that the content of Register 17_{16} has changed.

B.4.1.8 Bit 34 (Squitter Capability Subfield)

This bit should be set as specified in Table B-3-16.

The Squitter Capability Subfield (SCS) is interpreted as follows:

0 = squitter registers are not updated
1 = squitter registers are being updated

In addition, Annex 10, Volume IV states in §3.1.2.6.10.2.2.1:

SCS: This 1-bit Squitter Capability Subfield reports the capability of the transponder to transmit Extended Squitter position reports. It shall be set to ONE (1) if Registers 05_{16} and 06_{16} have been updated within the last ten ±1 seconds. Otherwise, it shall be set to ZERO (0).

Bit 34 is therefore an AND of Bits 1 and 2 of transponder Register 17_{16} and the setting of this bit is dynamic.

Note that Register 10_{16} will be broadcast twice in case Bit 34 changes. The first time because Bit 34 will change, then because Bit 36 will also toggle one minute later to indicate that the content of Register 17_{16} has changed.

B.4.1.9 Bit 35 (SI Code capability)

This bit should be set as specified in Table B-3-16, item 6.

The Surveillance Identifier (SI) bit is be interpreted as follows:

0 = no surveillance identifier code capability
1 = surveillance identifier code capability

In addition, Annex 10, Volume IV states in §3.1.2.6.10.2.2.1:

SIC: This 1-bit surveillance identifier capability subfield reports the capability of the transponder to support the Surveillance Identifier (SI) codes.

The setting of this bit is static. If the transponder software version handles SI codes then this bit should be set to (1).

B.4.1.10 Bit 36 (Common Usage GICB Capability Report)

This bit should be set as specified in Table B-3-16, item 7.

Bit 36 toggles each time the common usage GlCB capability report (Register 17_{16}) changes. To avoid the generation of too many broadcast capability report changes, Register 17_{16} is sampled at approximately one minute intervals to check for changes. The setting of this bit is therefore dynamic.

B.4.2 Transponder Registers 18_{16} to $1C_{16}$ (ICAO Doc 9871, §C.2.4.2)

The bits contained in Registers 18_{16} to $1C_{16}$ indicate the capability of the installation and are therefore specific to the platform on which the transponder is installed.

It is accepted that these bits can be set once the corresponding data has been received by the transponder over a period of time. This can happen at any time and not only during the power-on cycle of the transponder as equipment providing expected information could be powered on later.

Once a bit is set, it remains set until the power-off of the transponder.

B.4.3 Transponder Register 20_{16} (ICAO Doc 9871, §C.2.4.3)

B.4.3.1 Airborne Function

Annex 10, Volume IV requirements (Annex 10, Volume IV, §3.1.2.9.1.1) state the following for data in transponder Register 20_{16}:

> *AIS, aircraft identification subfield in MB.* The transponder shall report the aircraft identification in the 48-bit (41 – 88) AIS subfield of MB. The aircraft identification transmitted shall be that employed in the flight plan. When no flight plan is available, the registration marking of the aircraft shall be inserted in this subfield.
>
> ***Note:*** *When the registration marking of the aircraft is used, it is classified as 'fixed direct data' (see Annex 10 Vol. IV, §3.1.2.10.5.1.1). When another type of aircraft identification is used, it is classified as 'variable direct data' (see Annex 10 Vol. IV, §3.1.2.10.5.1.3)."*

When the aircraft installation does not use an external source to provide the aircraft identification (most of the time it will be the call sign used for communications between pilot and controllers), the text above means that the aircraft identification is considered as variable direct data. It also means that such data characterize the flight condition of the aircraft (not the aircraft itself) and are therefore subject to dynamic changes. It further means that variable direct data are also subject to the following requirement when data become unavailable.

Paragraph §B.2.1 states:

> "If data is not available for a time no greater than twice the specified maximum update interval or 2 seconds (whichever is the greater), the status bit (if specified for that field) shall indicate that the data in that field are invalid and the field shall be ZEROed."

Therefore, if the external source providing the aircraft identification fails or delivers corrupted data, transponder Register 20_{16} should be ZEROed. It should not include the registration marking of the aircraft since the airborne installation has initially been declared as providing variable direct data for the aircraft identification.

The loss of the aircraft identification data will be indicated to the ground since transponder Register 20_{16} will be broadcast following its change. If the registration marking of the aircraft was inserted in lieu of the call sign following a failure of the external source, it would not help the ground systems since the registration marking of the aircraft is not the information that was inserted in the aircraft flight plan being used by the ground ATC systems.

In conclusion, the aircraft identification is either fixed (aircraft registration) or variable direct data (call sign). It depends whether the aircraft installation uses a data source providing the call sign; if so, data contained in transponder Register 20_{16} should meet the requirement of the ICAO SARPs. When data becomes unavailable because of a data source failure, transponder Register 20_{16} should contain ALL ZEROs.

B.4.3.2 Ground Considerations

Aircraft identification data can be used to correlate surveillance information with flight plan information. If the data source providing the aircraft identification fails, the aircraft identification information will no longer be available in the surveillance data flow. In this case, the following means could enable the ground system to continue correlating the surveillance and flight plan information of a given target.

If the aircraft identification is used to correlate surveillance and flight plan data, extra information such as the Mode A code, if any, and the ICAO 24-bit aircraft address of the target could be provided to the flight data processing system. This would enable the update of the flight plan of the target with this extra information.

In case the aircraft identification becomes unavailable, it would still be possible to correlate both data flows using (for example) the ICAO 24-bit aircraft address information to perform the correlation. It is therefore recommended that ground systems update the flight plan of a target with extra identification information that is available in the surveillance data flow, e.g., the ICAO 24-bit aircraft address, the Mode A code (if any) or the tail number (if available from transponder Register 21_{16}).

This extra identification information might then be used in lieu of the aircraft identification information contained in transponder Register 20_{16} in case the data source providing this information fails.

B.4.4 Transponder Register 40_{16} (ICAO Doc 9871, §C.2.4.4)

Paragraph §B.4.2.1 gives a general example of what are the different selected altitudes and the relationship with the target altitude and introduces the meaning of the different parameters and notions used in this section.

Paragraphs §**Error! Reference source not found.**~~B.4.2.2~~, §B.4.4.2~~B.4.2.3~~ and §B.4.4.3~~B.4.2.4~~ provide more detailed information for some specific platforms.

B.4.4.1 General Example for the Loading of Data in Register 40_{16}

Figure B-4-1 provides a general example for the loading of data in Register 40_{16}.

The goal of Figure B-4-1 is to clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude, and also to clarify how the target altitude of the aircraft and the MCP/FCU mode bits are determined depending on the phase of flight in the vertical profile.

Notions and terms used:

- Cleared flight level: Flight level cleared by the controller, i.e., the flight level aircraft should reach and maintain.

- MCP/FCU selected altitude:

  - The Autopilot Flight Director System (AFDS) is more commonly known as autopilot (A/P). Its task is to laterally and vertically control the aircraft when selected by the crew. In general in modern aircraft, the AFDS is a system consisting of several individual Flight Control Computers (FCCs) and a single Flight Control Panel (FCP) mounted directly between the pilots just under the windshield. Fundamentally, the autopilot attempts to acquire or maintain target parameters determined either by manual inputs made by the pilot or by computations from the Flight Management System.

  - MCP: Mode Control Panel is the usual name given on Boeing platforms to the FCP which provides control of the Autopilot, Flight Director, Altitude Alert and Autothrottle System. The MCP is used to select and activate Autopilot Flight Director System (AFDS) modes and establish altitudes, speeds and climb/descent profiles.

  - FCU: Flight Control Unit is similar to MCP but for Airbus platforms.

  - MCP/FCU selected altitude: The altitude set by pilots on the MCP/FCU controlling the auto-pilot system. In the great majority of cases pilots set the MCP/FCU altitude to the altitude cleared by Air Traffic Control (ATC) before engaging a vertical mode. The autopilot will try to reach this MCP/FCU selected altitude using different selectable vertical modes: constant vertical rate (e.g., V/S), Flight Level change at a given airspeed (e.g., FL CH), vertical path given by the FMS (VNAV), and maintain it using the altitude hold mode (ALT HOLD).

    Note: *If the aircraft is not equipped with an autopilot this information may be derived from equipment generating an alert when the FL is reached (e.g., altitude alerter system).*

- FMS selected altitude:

- The Flight Management System (FMS or FMC for Flight Management Computer) is a computer onboard aircraft that controls the navigation, performance, flight planning, and guidance aspects of flight. The FMS navigation component determines where the aircraft is. The FMS performance component calculates necessary performance data. The FMS flight planning component allows for the creation and modification of flight plans. The FMS guidance component issues commands necessary to guide the aircraft along the route programmed into the FMS. The current and programmed paths of the aircraft are monitored three-dimensionally, by flying from waypoint to waypoint and by obeying crossing restrictions.

- The FMS guidance component will therefore compute selected altitude constraints to be reached at different points. This is known as FMS selected altitude. These selected altitudes are used to control the aircraft in specific modes of autopilot for example when Vertical Navigation mode (VNAV) is selected on MCP/FCU. VNAV mode is the highest level of vertical profile automation, and maximizes fuel economy.

- Target altitude: this is the next altitude at which the aircraft will level-off if in a climb or descent, or the aircraft current intended altitude if it is intending to hold its altitude.

  - The target altitude may be:

    - The MCP/FCU selected altitude when the autopilot is directly controlled by command entered by the crew()
    - The FMS selected altitude when in VNAV or similar modes.
    - The current altitude.
    - Unknown.

- MCP/FCU mode bits:

  - VNAV indicates when a VNAV or equivalent mode in which the A/P is controlled by FMS is selected.

  - ALT HOLD indicates when A/P Alt Hold mode is selected. It does not correspond to a general altitude capture and does not cover VNAV hold situation.

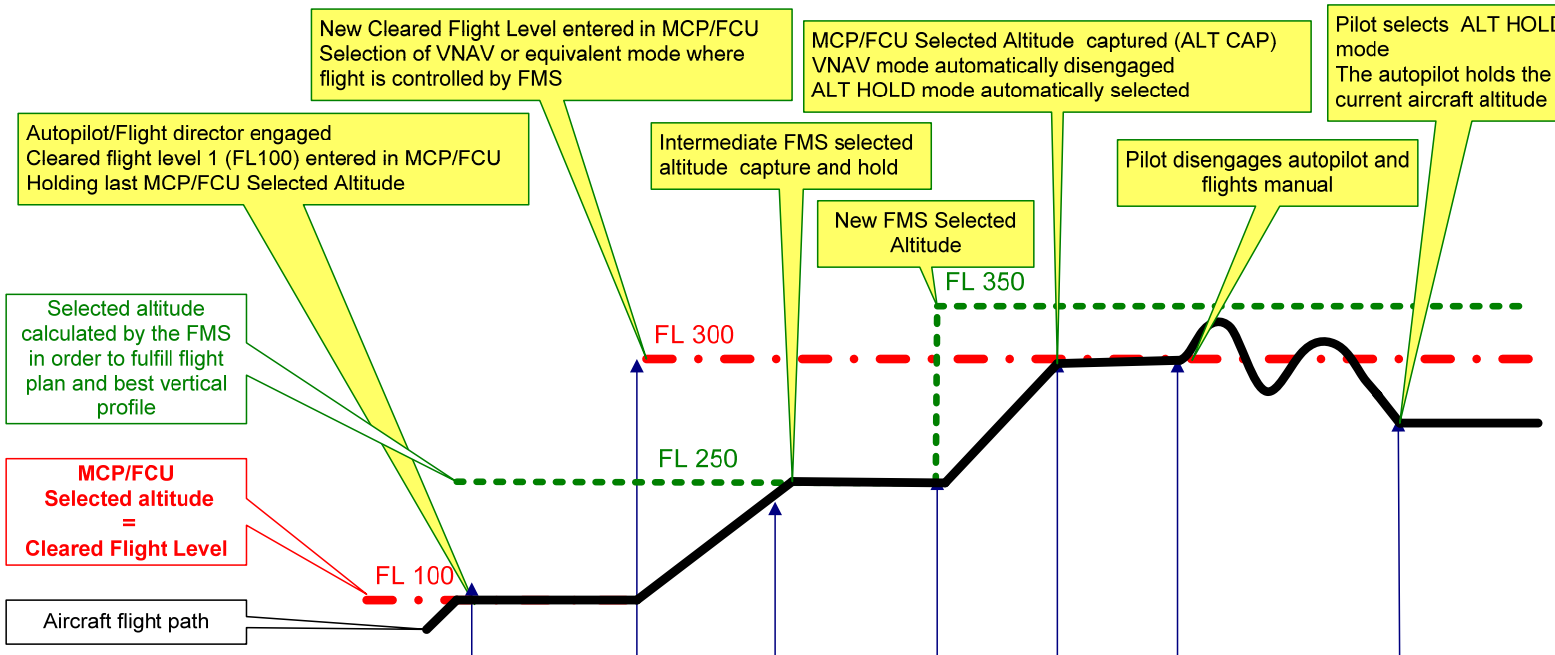
  - Approach indicates that a mode to capture ILS localizer and glide slope is engaged.

- Priority of MCP/FCU selected altitude on FMS selected altitude:

  The MCP/FCU selected altitude is the altitude that the aircraft shall not violate and therefore it has always priority on FMS selected altitude.

EXAMPLE for the loading of data in Register 40Hex

Hypothesis on information available to transponder
The FMS selected altitude (calculated by the FMS) and the target altitude source information are available on aircraft buses (this is not necessary the case today) as well as the MCP/FCU mode bits. Bits 48 and 54 are set to 1 all the time with this hypothesis. The reverse hypothesis would require bits 48-51 and bits 54-56 to be all set to 0 and the FMS selected altitude field to be all zeroed.



Register 40Hex content	MCP/FCU Selected Altitude	100	300	300	300	300	300	300
	FMS Selected Altitude	250	250	250	350	350	350	350
	MCP/FCU Mode bits Provided	1	1	1	1	1	1	1
	VNAV	0	1	1	1	0	0	0
	Alt Hold	1	0	0	0	1	0	1
	Approach	0	0	0	0	0	0	0
	Target altitude (Unknown, Altitude,FCU/MCP, FMS)	FCU/MCP	FMS	FMS	FCU/MCP	FCU/MCP	unknown	Altitude
	Step	1	2	3	4	5	6	7

Figure B-4-1: General Example for the Loading of Data in Register 40_{16}

Explanation of the different steps in Figure B-4-1:

Generally, Figure B-4-1 shows a theoretical sequence of cases which should not be considered as a real operational sequence. For example, some steps may be more realistic when the aircraft is in descent.

Step 1: The MCP/FCU selected altitude has been set to first cleared flight level (FL100). The Autopilot/Flight Director is engaged and the aircraft is holding the latest MCP/FCU selected altitude which has been reached before Step1. The target altitude is the MCP/FCU selected altitude. VNAV mode is not engaged. The FMS selected altitude is not the target altitude.

Step 2: A new clear flight level has been allocated to the aircraft by ATC. The pilot has entered this value into the MCP/FCU resulting in a new MCP/FCU selected altitude. The pilot has engaged the VNAV mode. The aircraft speed/path is determined by the FMS. The FMS contains a flight path with an altitude restriction at a given waypoint (FL250). The FMS selected altitude corresponds to the associated altitude restriction. This FMS selected altitude is less than the MCP/FCU selected altitude and therefore becomes the target altitude to which the aircraft is climbing.

Step 3: There is an altitude restriction associated with a waypoint. The aircraft has captured and is maintaining the FMS selected altitude until crossing the way point. The VNAV mode remains active. In an operational environment, aircrew should also set the MCP/FCU altitude to the intermediate levels on a stepped climb SID if workload permits.

Step 4: The waypoint with restricted altitude is passed. A new FMS selected altitude is now valid. The aircraft resumes its climbing to try to reach this new FMS selected altitude. VNAV mode is still engaged. Although the aircraft is trying to reach the FMS selected altitude (FL350) it will level-off at the MCP/FCU selected altitude which is lower than the FMS selected altitude therefore the selected altitude is the MCP/FCU selected altitude.

Step 5: The MCP/FCU selected altitude is lower than the FMS selected altitude. The aircraft therefore first approaches this MCP/FCU selected altitude which is a limit to not violate. This MCP/FCU altitude is captured and held by the aircraft. This automatically disengages the VNAV mode.

Step 6: The flight crew has disengaged the autopilot and is flying the aircraft manually. The target altitude is not known. However on an operational point of view it must be noted that such mode would not be allowed in regulated airspace unless the aircrew had declared an emergency or had obtained a new ATC clearance. In the latter case the ATC clearance should be entered in the MCP/FCU. It is more probable that this case may happen on a “descent when ready” profile. In all cases the MCP/FCU selected altitude may still be useful because it should be the value used in the altitude alerter.

Step 7: The pilot selects altitude hold (Alt Hold or equivalent mode) making the current altitude equivalent to the target altitude. Note that although MCP/FCU selected altitude could become the same (pilot entering the new flight level in the MCP/FCU) this is not mandatory and therefore only altitude represents with full confidence the level the aircraft is maintaining.

B.4.4.1.1 Target Altitude Summary

If MCP/FCU altitude is between your current altitude and FMS Selected Altitude, then the target altitude is MCP/FCU. If VNAV is engaged and the previous case is not in effect, then FMS is the target altitude. If Alt Hold is selected and the current altitude is not equal to either of the selected altitudes, then target altitude is altitude.

B.4.4.1.2 Possible Uses of Selected Altitude and Target Altitude

1. MCP/FCU selected altitude will be downlinked as an additional read-back in order to check that the cleared flight level has been correctly understood and entered in the airborne system by the pilot.

2. Target altitude and associated mode of flight may be of interest to reduce the Short Term Conflict Alert false alarm rate.

B.4.4.1.3 Target Altitude Implementation Difficulties

It is recognized that all information to determine which altitude is the target altitude or which mode of flight is currently used may not always be available to the transponder in the current airborne implementation. In addition it may be very dependent on the platform. It is therefore preferable to set to ZERO (0) the corresponding bits of Register 40_{16} rather than sending wrong information.

B.4.4.2 Transponder Register 40_{16} on Boeing 747-400, 757 and 767 Aircraft

In order to clarify how selected altitude information from the altitude control panel and target altitude is reported in transponder Register 40_{16}, a mapping has been prepared to illustrate how the status and mode bits can be derived.

Transponder Register bit #	Description	Label
48	Status of mode bits	SSM of 272 and 273
49	Managed Vertical Mode	272 bit 13
50	Altitude Hold Mode	272 bit 9 / 273 bit 19
51	Approach Mode	272 bit 9 / 273 bit 19
54	Status of Target Altitude source bits	SSM of new label (TBD)
55 – 56	Target Altitude source bits	New label (TBD)

The selected altitude from the mode control panel may be obtained from label 102 (source ID 0A1). The status bit may be derived from the SSM of label 102.

B.4.4.3 Setting of the Target Altitude Source Bits (Bits 54 – 56)

These bits should be set as required in Table B-3-64, item 5:

Bit 54 indicates whether the target altitude source bits (55 and 56) are actively being populated.

0 = No source information provided
1 = Source information deliberately provided

Bits 55 and 56, indicate target altitude source:

00 = Unknown
01 = Aircraft altitude
10 = FCU/MCP selected altitude
11 = FMS selected altitude

Aircraft which are not equipped with the logic described in §B.4.3.1~~B.4.1.1~~ and §B.4.3.2~~B.4.1.2~~ are not able to determine the target altitude source of the aircraft. In that case bit 54 should be set to ZERO (0) (no source information provided), and bits 55 and 56 should be set to 00 (unknown).

B.4.5 Transponder Register 50_{16} (ICAO Doc 9871, §C.2.4.5)

When ARINC 429 data is used, the following is an example implementation:

BDS Bit #:	Data Bit #	Description
1	STATUS	1 = Valid Data
2	SIGN	1 = left (left wing down)
3		MSB = 45 degrees
4		
5		Roll Angle
6		ARINC Label 325
7		
8		Range = [-90, +90]
9		
10		
11		LSB = 45 / 256 degrees
12	STATUS	1 = Valid Data
13	SIGN	1 = west (e.g., 315º = 45º)
14		MSB = 90 degrees
15		
16		
17		True Track Angle
18		ARINC Label 313
19		
20		Range = [-180, +180]
21		
22		
23		LSB = 90 / 512 degrees
24	STATUS	1 = Valid Data
25		MSB = 1024 knots
26		
27		
28		Ground Speed
29		ARINC Label 312
30		
31		Range = [0, 2046]
32		
33		
34		LSB = 1024 / 512 = 2 knots
35	STATUS	1 = Valid Data
36	SIGN	1 = minus
37		MSB = 8 degrees per second
38		
39		Track Angle Rate
40		ARINC Label 335
41		
42		Range = [-16, +16]
43		
44		
45		LSB = 8 / 256 degrees per second
46	STATUS	1 = Valid Data
47		MSB = 1024 knots
48		
49		True Air Speed
50		ARINC Label 210
51		
52		Range = [0, 2046]
53		
54		
55		
56		LSB = 1024 / 512 = 2 knots

The status bits are determined as explained in §B.2.2.2. The data is rounded as specified in §B.2.2.2. The encoding accuracy of the data in the subfield is ±½ LSB by rounding.

For ARINC GAMA configuration, label 335 is not used for the track angle rate but for another parameter. For this particular ARINC configuration the track angle rate field should be loaded with ALL ZEROs. In such cases, ground applications can compute the equivalent of the track angle rate thanks to the true air speed and the roll angle information.

B.4.6 Transponder Register 60_{16} (ICAO Doc 9871, §C.2.4.6)

When ARINC 429 data is used, the following is an example implementation:

BDS Bit #:	Data Bit #	Description
1	STATUS	1 = Valid Data
2	SIGN	1 = West (e.g., 315º = 45º)
3		MSB = 90 degrees
4		
5		Magnetic Heading
6		ARINC Label 320
7		
8		Range = [-90, +90]
9		
10		
11		
12		LSB = 90 / 512 degrees
13	STATUS	1 = Valid Data
14		MSB = 512 knots
15		
16		
17		Indicated Air Speed
18		ARINC Label 206
19		
20		Range = [0, 1023]
21		
22		
23		LSB = 512 / 512 = 1 knot
24	STATUS	1 = Valid Data
25		MSB = 2048
26		
27		
28		Mach
29		ARINC Label 205
30		
31		Range = [0, 4092]
32		
33		
34		LSB = 2048 / 512
35	STATUS	1 = Valid Data
36	SIGN	1 = below
37		MSB = 8192 ft/min
38		
39		Barometric Altitude Rate
40		ARINC Label 212
41		
42		Range = [-16384, +16352]
43		
44		
45		LSB = 8192 / 256 = 32 ft/min
46	STATUS	1 = Valid Data
47	SIGN	1 = below
48		MSB = 8192 ft/min
49		
50		Interial Vertical Velocity
51		ARINC Label 365
52		
53		Range = [-16384, +16352]
54		
55		
56		LSB = 8192 / 256 = 32 ft/min

The status bits are determined as explained in §B.2.2.2. The data is rounded as specified in §B.2.2.2. The encoding accuracy of the data in the subfield is ±½ LSB by rounding.

"Barometric Altitude Rate" contains values that are solely derived from barometric measurement. The Barometric Altitude Rate may be very unsteady and may suffer from barometric instrument inertia.

The "Inertial Vertical Velocity" is also providing information on vertical attitude of the aircraft but it comes from equipments (IRS, AHRS) which use different sources used for navigation. The information is a more filtered and smoothed parameter.